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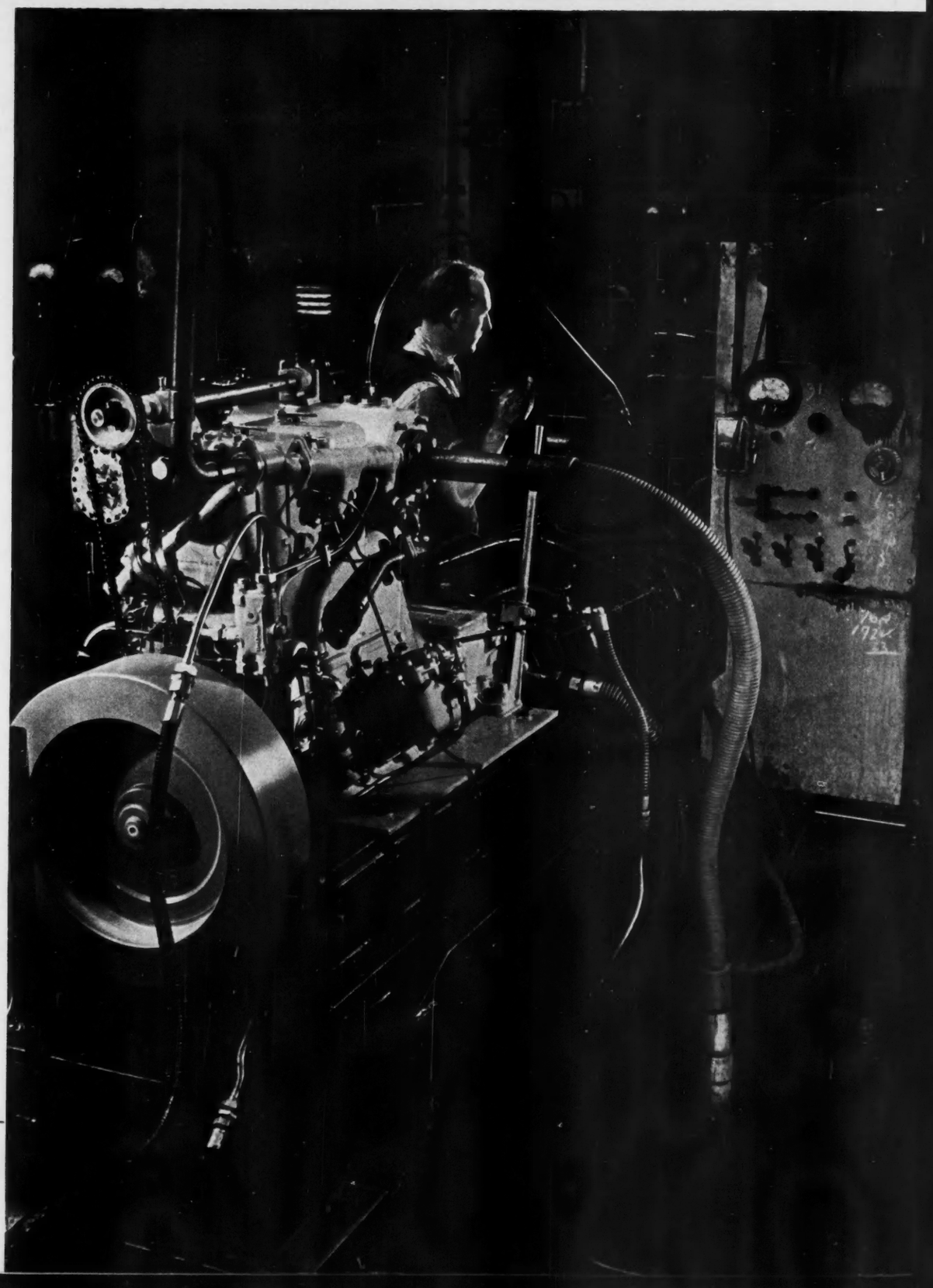

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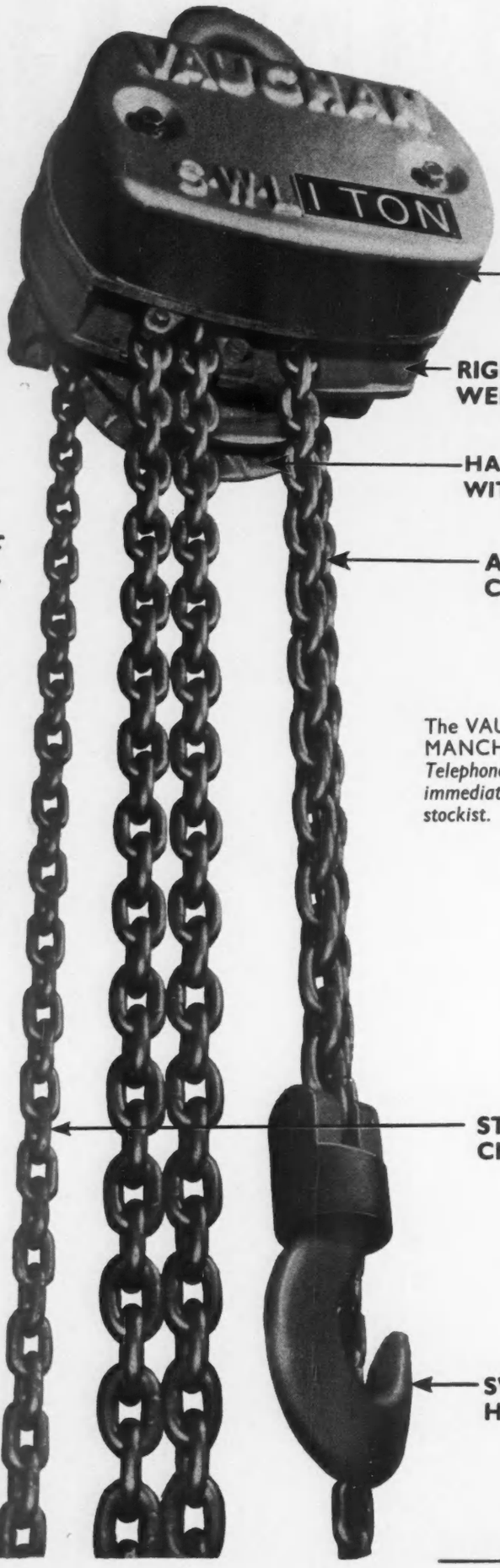

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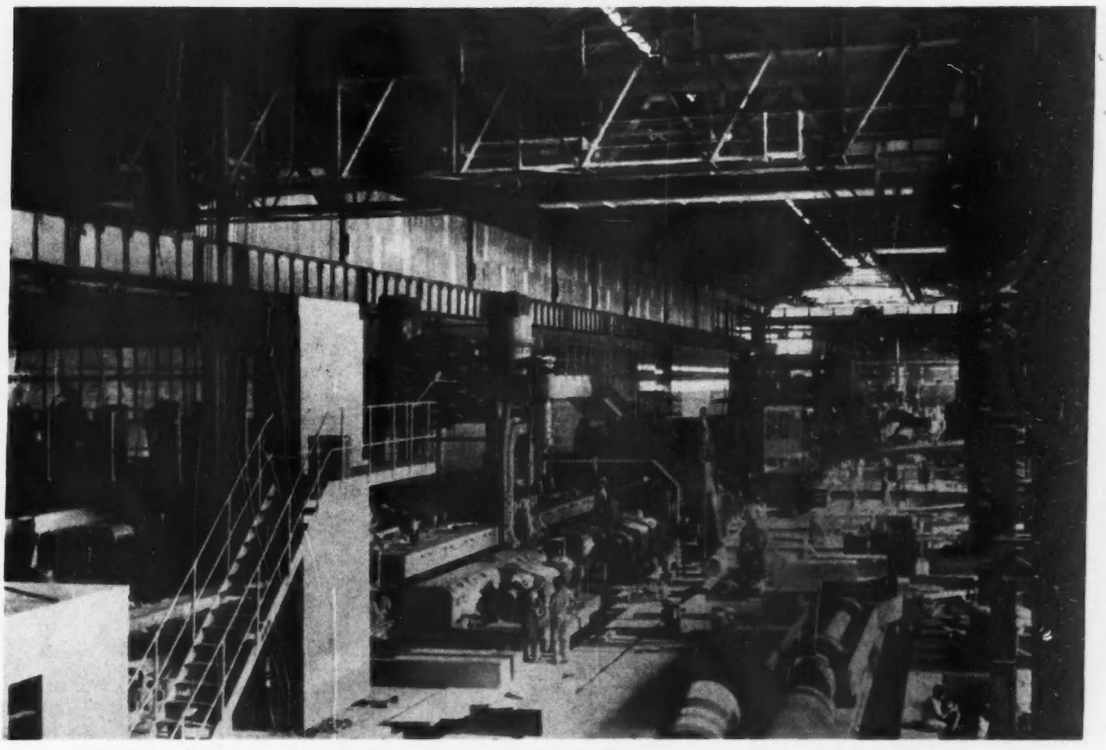

The Davy-United 42" x 102" Reversing Blooming Mill, the primary rolling unit of the whole Durgapur steelworks, seen in an advanced stage of site installation. This mill is designed to roll over a million ingot tons a year.

at Durgapur

As members of ISCON, Davy-United are responsible for the Rolling Mills, the Central Engineering Maintenance Department, the Iron and Steel Foundry and the Wheel and Axle Plant at Durgapur—in fact, for more than a quarter of the whole Works.

The Iron and Steel Foundry and the Central Engineering Maintenance Department are both already in operation. The Foundry is laid out to make 20,000 tons of ingot moulds each year for the steelmaking plant, as well as a further 10,000 tons of assorted iron, steel and non-ferrous castings. The Central Engineering Maintenance Department is fully equipped to undertake the servicing and repair operations required to keep a large steelworks at full productive efficiency.

Now Durgapur's mills have begun rolling steel. The 42" Blooming Mill, the 32" Intermediate Blooming Mill and the Continuous Billet Mill are all now coming into production. The rest of the mills will roll in twelve months time; they will be followed by the Wheel and Axle Plant. Then will Durgapur realise its full potential of a million more tons of steel products each year for India.

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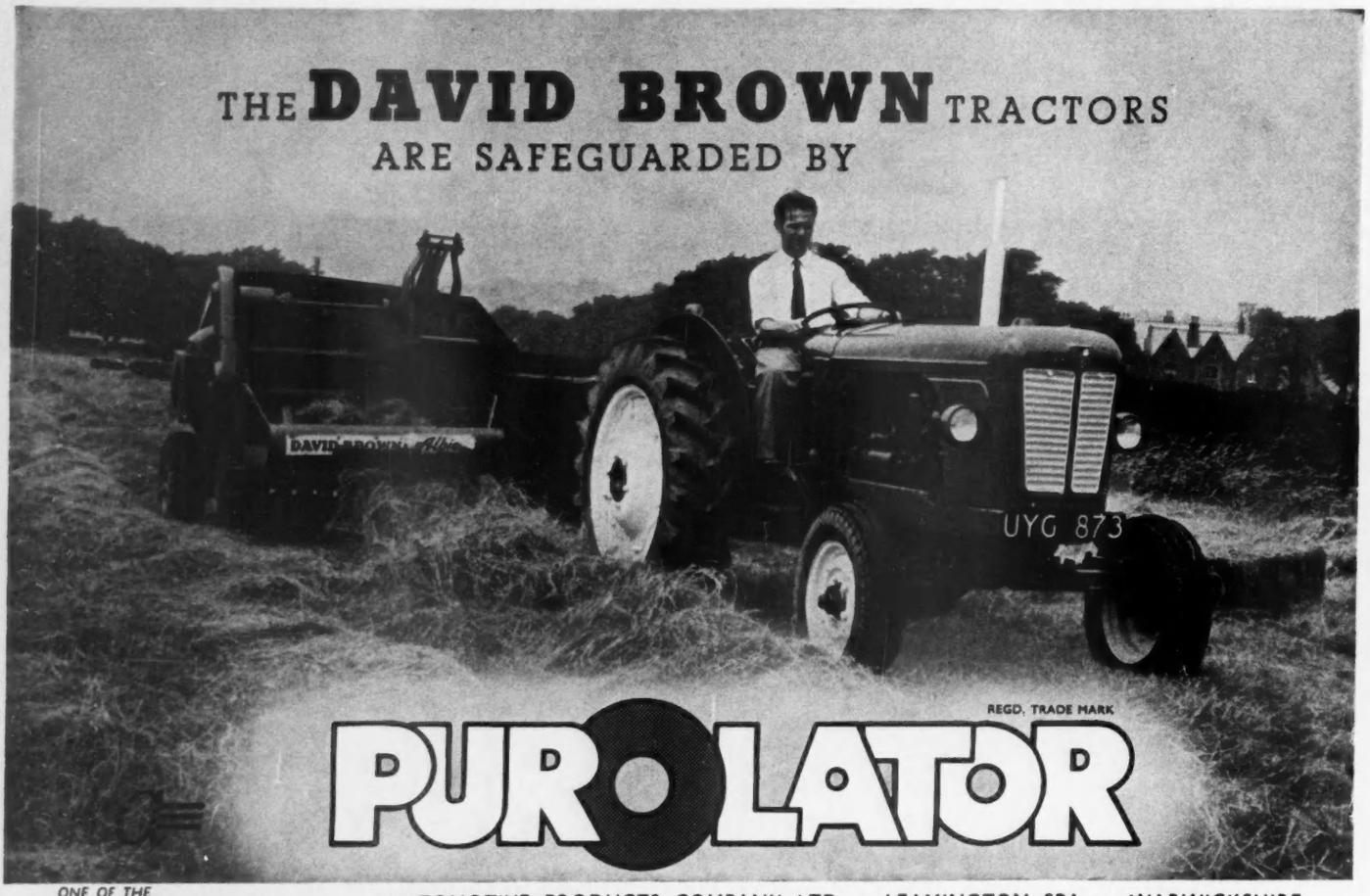

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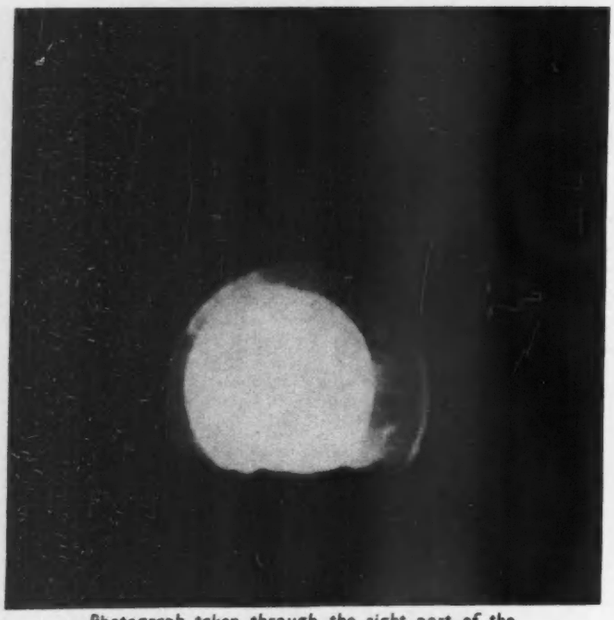

Photograph taken through the sight port of the combustion chamber of an Economic Boiler—approximate fuel output 350 lbs. per hour—CO_2 of over 13%—Smoke Number between 1 and 2

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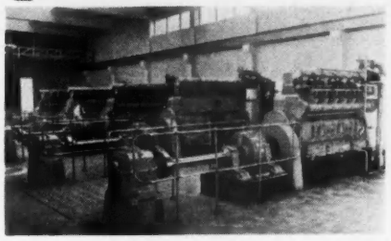
A few of the many

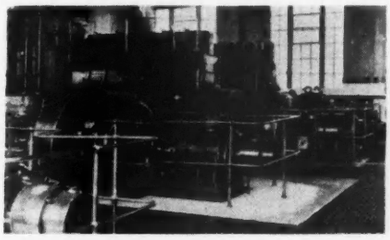
NATIONAL

DUAL FUEL ENGINE INSTALLATIONS



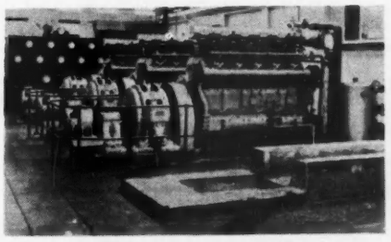
Pumping Station Equipment at the Sewage Works, Derby, comprises two National R4A6 straight oil engines and three R4AP6 dual-fuel engines, each driving a centrifugal pump. Each engine has a continuous rating of 231 b.h.p. at 600 r.p.m.

Parr Sewage Works, St. Helens, Lancashire, derives its power requirements for sewage treatment from four National R4AP8 dual-fuel engines each developing 370 continuous b.h.p. at 600 r.p.m. and each driving a Lancashire Dynamo and Crypto Ltd. alternator.

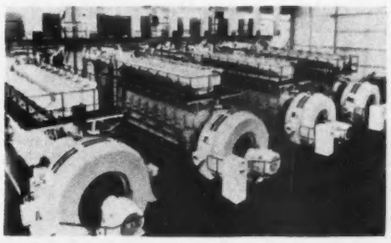


The seven cylinder dual-fuel engine in the centre of our illustration has run non-stop for 15,100 hours at the Dartford works of the West Kent Main Sewerage Board. Two of the four National engines in this station have been installed for over 20 years.

National Diesel and dual-fuel engines installed at No. 2 Olefine Plant for I.C.I. (Heavy Organic Chemicals) Limited, Wilton, Yorkshire. One of the largest Diesel and dual-fuel compressor stations in the United Kingdom and comprises 13 National engines developing 11,059 b.h.p.



Engine room at the Cippenham Sewage Disposal Works, Slough, where five National R4AP5 230 b.h.p. dual-fuel engines provide power for the station.



4-1,000 kW. pressure charged dual-fuel sets running on natural gas at Bahrein. These are the first British engines of this type installed in the Persian Gulf.

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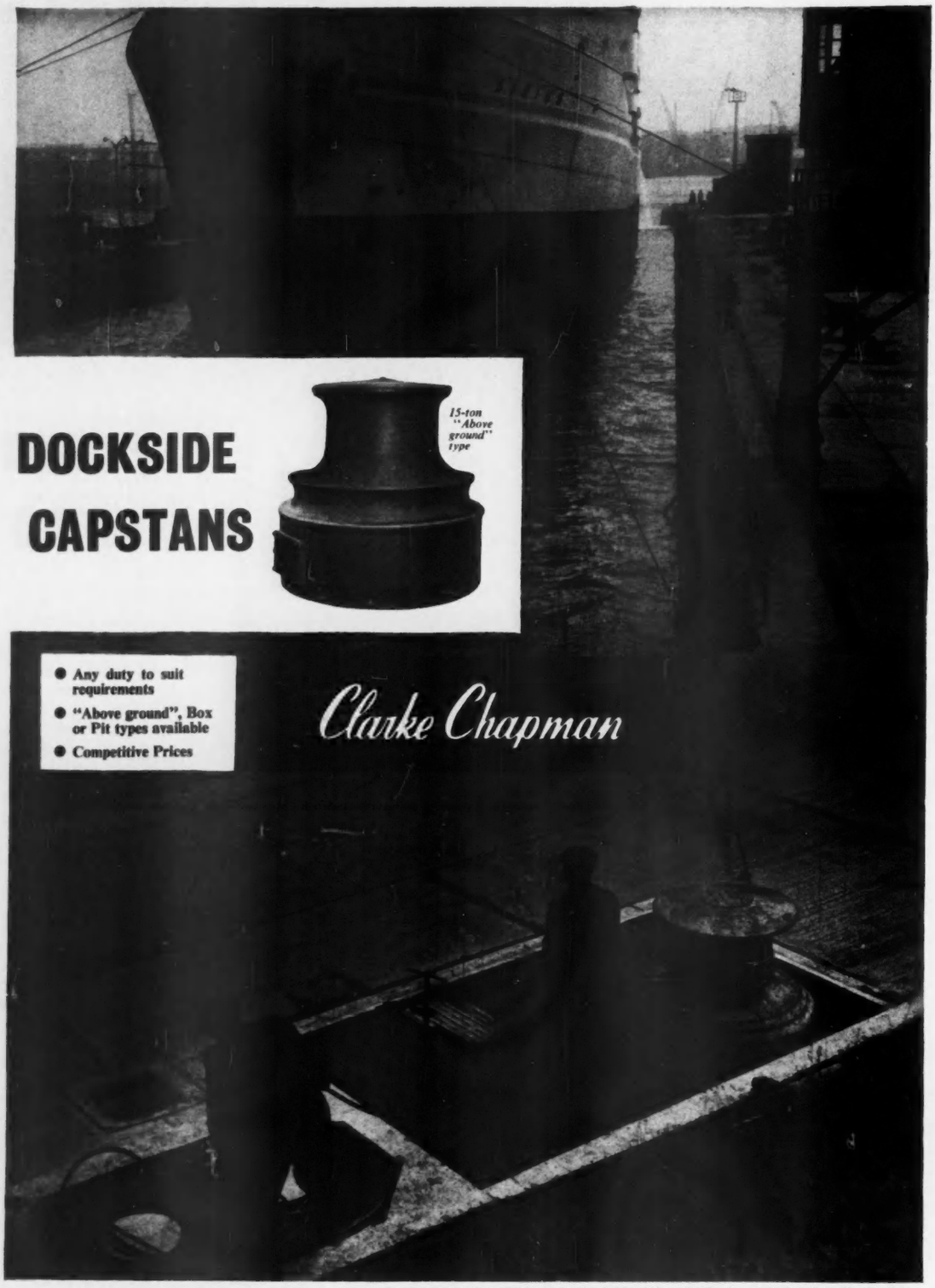

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Calculating the load in reverse rotation during testing of a twin cylinder engine. (*Nurnberg photograph for* ENGINEERING.)

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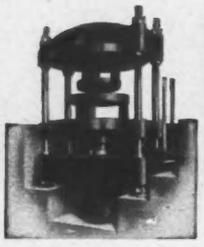

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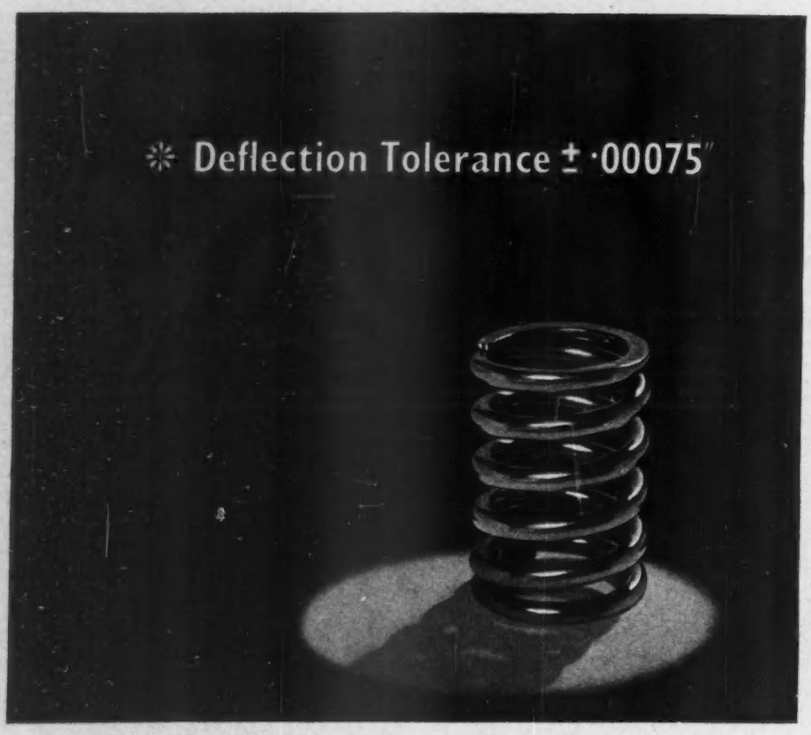

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Under the title "Outlook 1961" the four issues of "Engineering" in January will take a forward look at the whole panorama of engineering industries. Editorial treatment will focus attention on technical developments, but will also consider commercial, manpower, political, economic, and other non-technical factors.

begins 6 January

The first of the four special issues will review these three industrial groups: (a) Machine Tools, Mechanical Handling Equipment, and other Production Plant; (b) Telecommunications and Electronics, including Radio, Television and Radar; (c) Armaments, including Naval Ships, Military Vehicles, Aircraft and Rockets.

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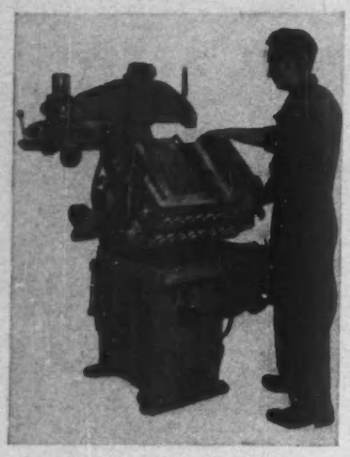

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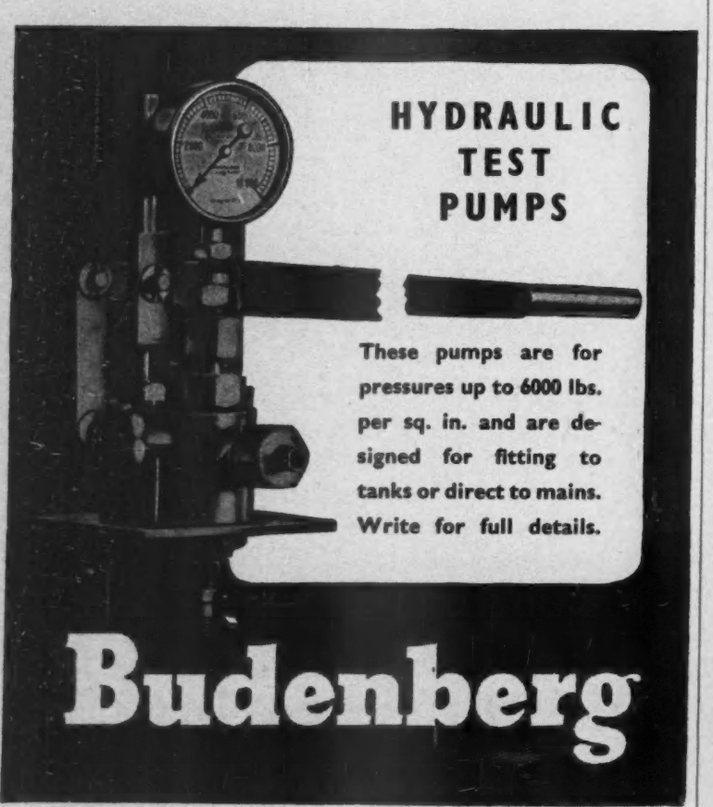

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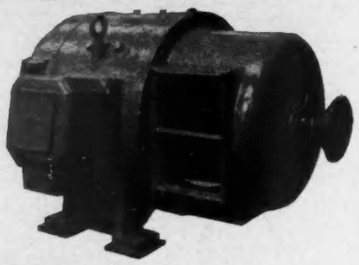

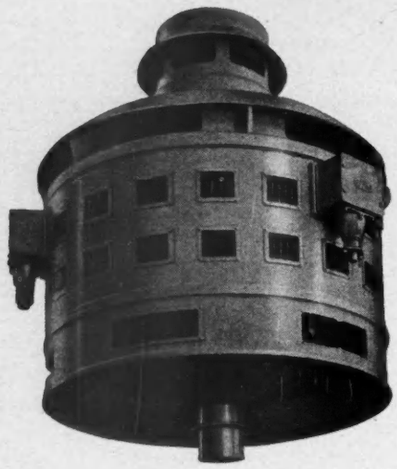

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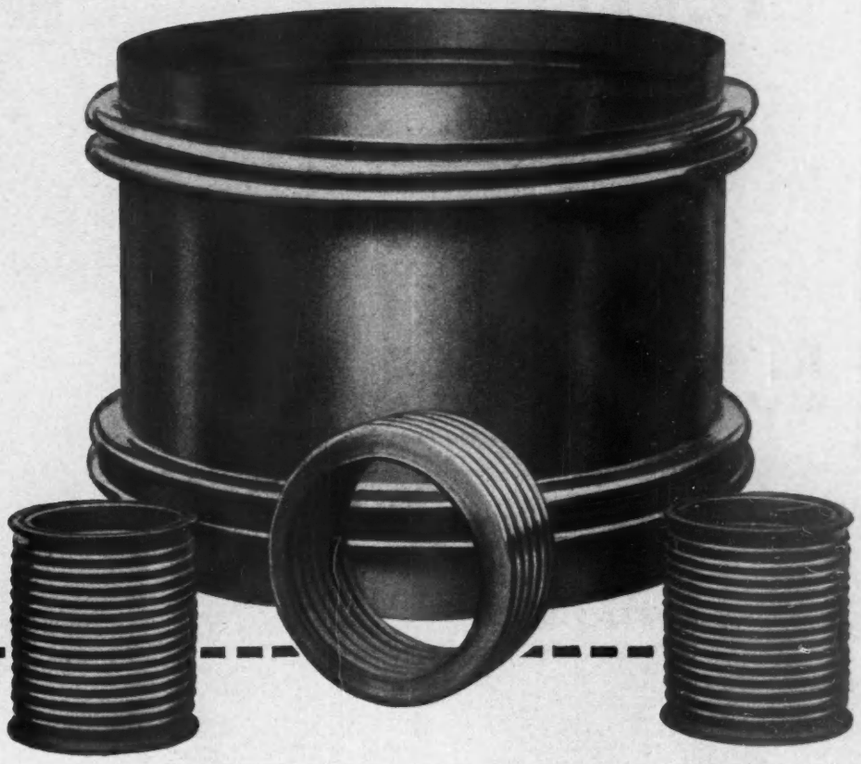
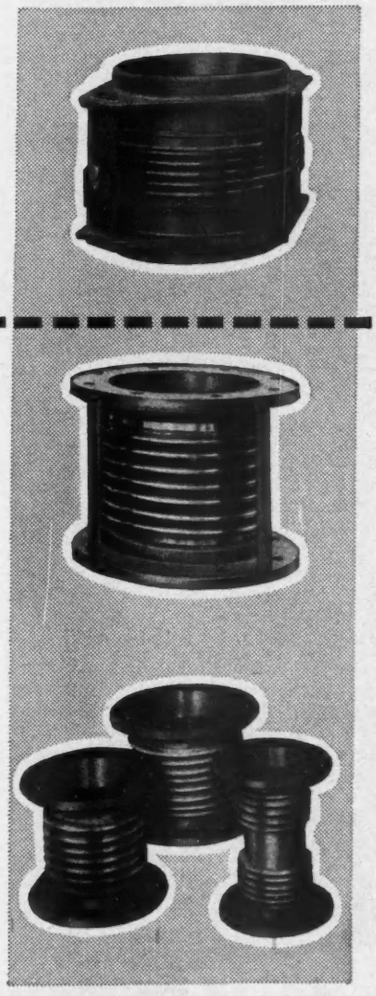
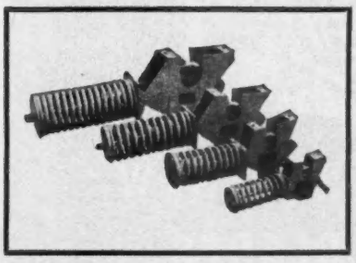
give Genflexibility to piping that's always on the move







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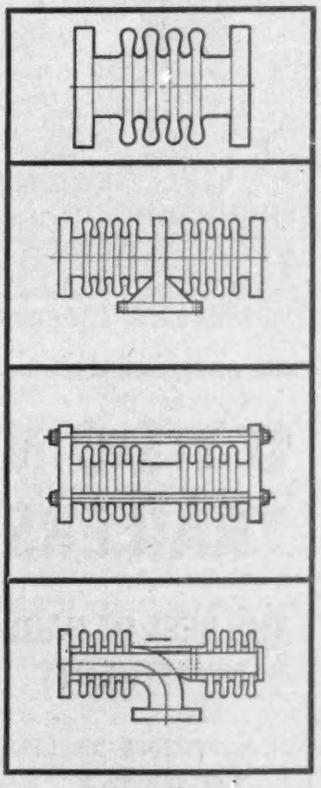
the perfect combination for controlling movement and stresses in pipelines.

Vokes Genspring suspension equipment when used in conjunction with Genflex expansion joints gives a unique, absolutely reliable and versatile system of pipework control. Illustrated (bottom left) are four Genspring constant support hangers from the 'M' range which is capable of supporting loads from 315 lb. to 97,800 lb.
Other illustrations on this page show a few of the many sizes and types of Genflex expansion joints produced to accommodate various pipe movements.



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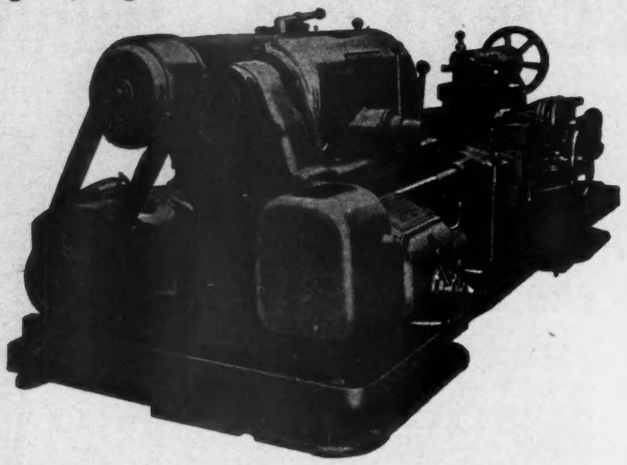

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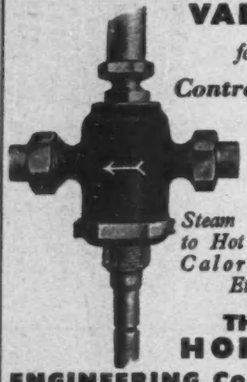

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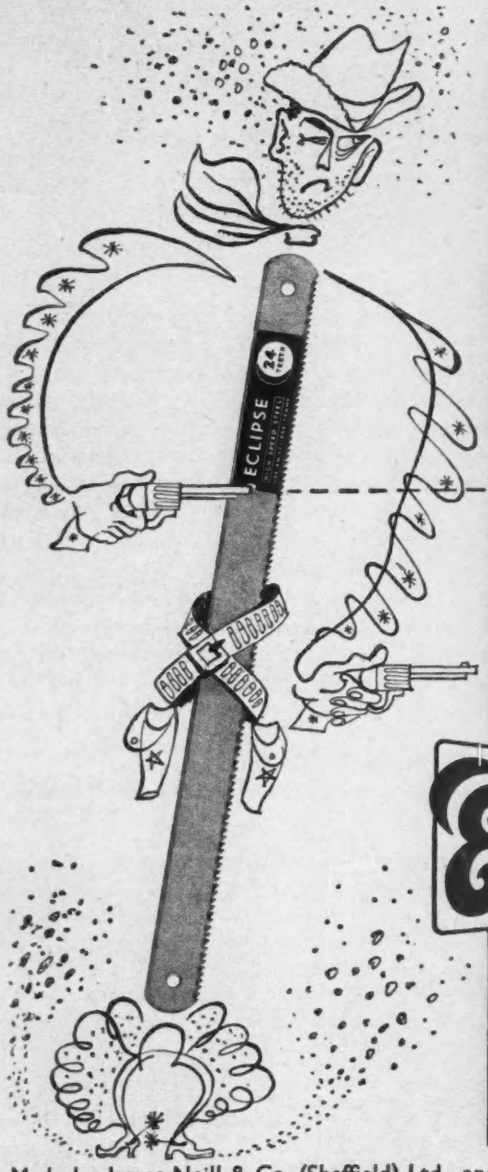

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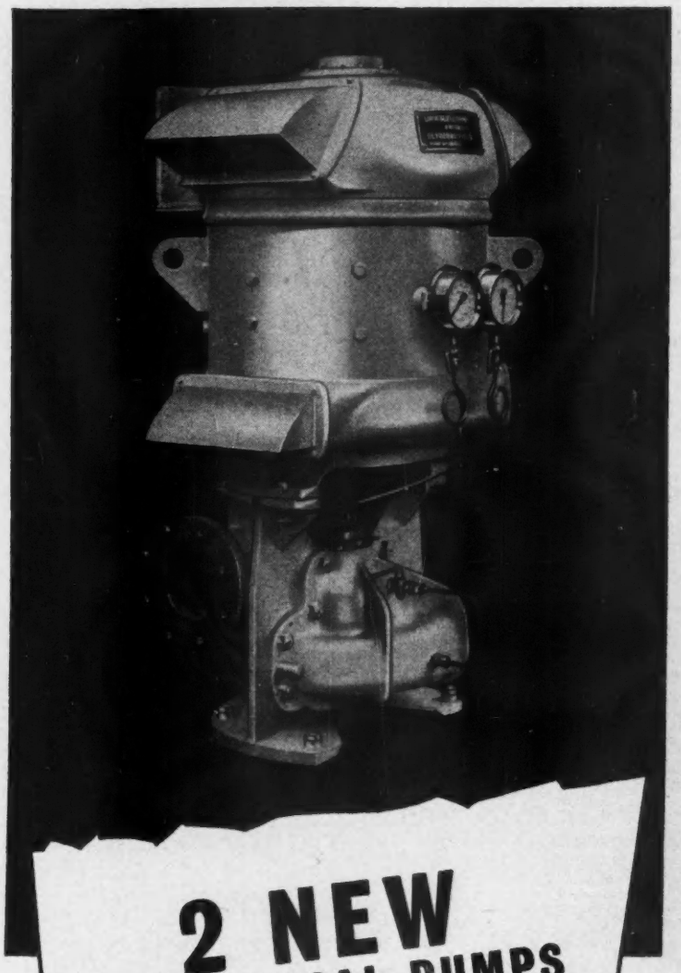

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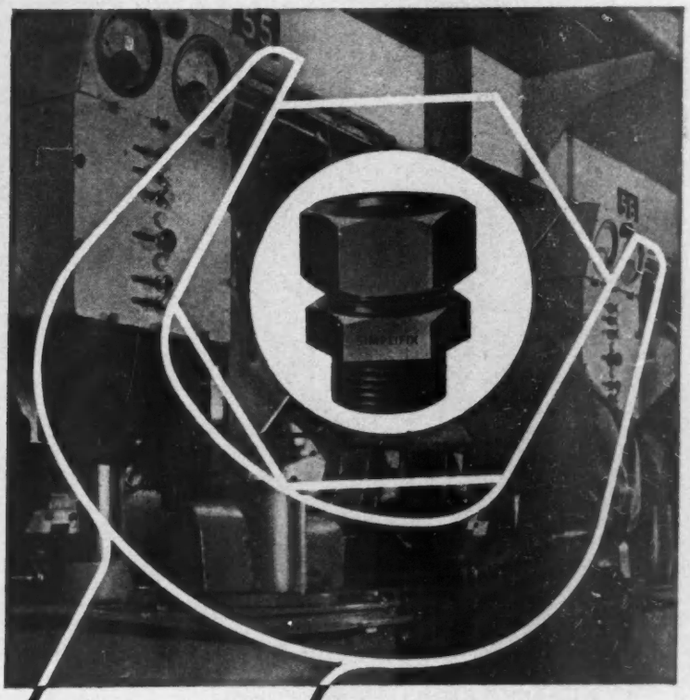

The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.

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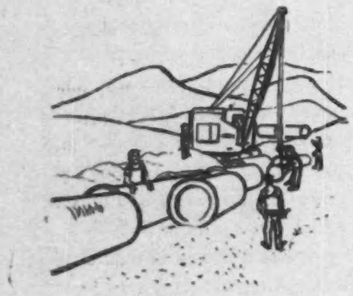

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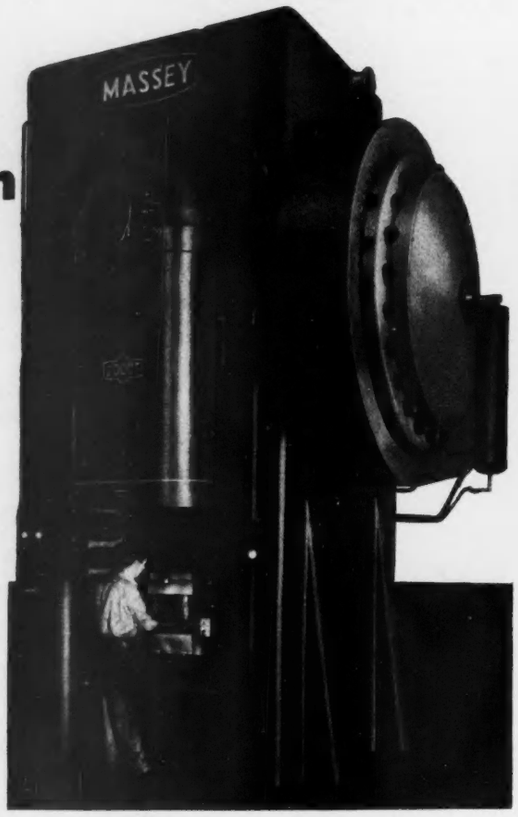

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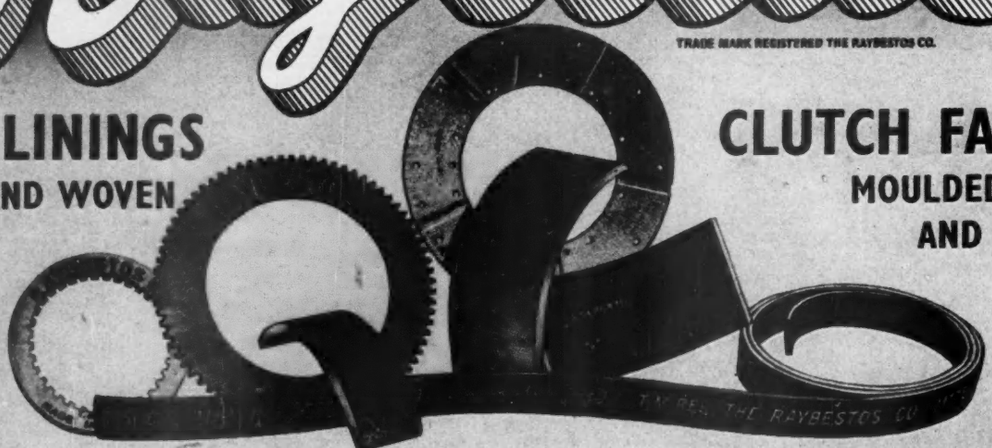

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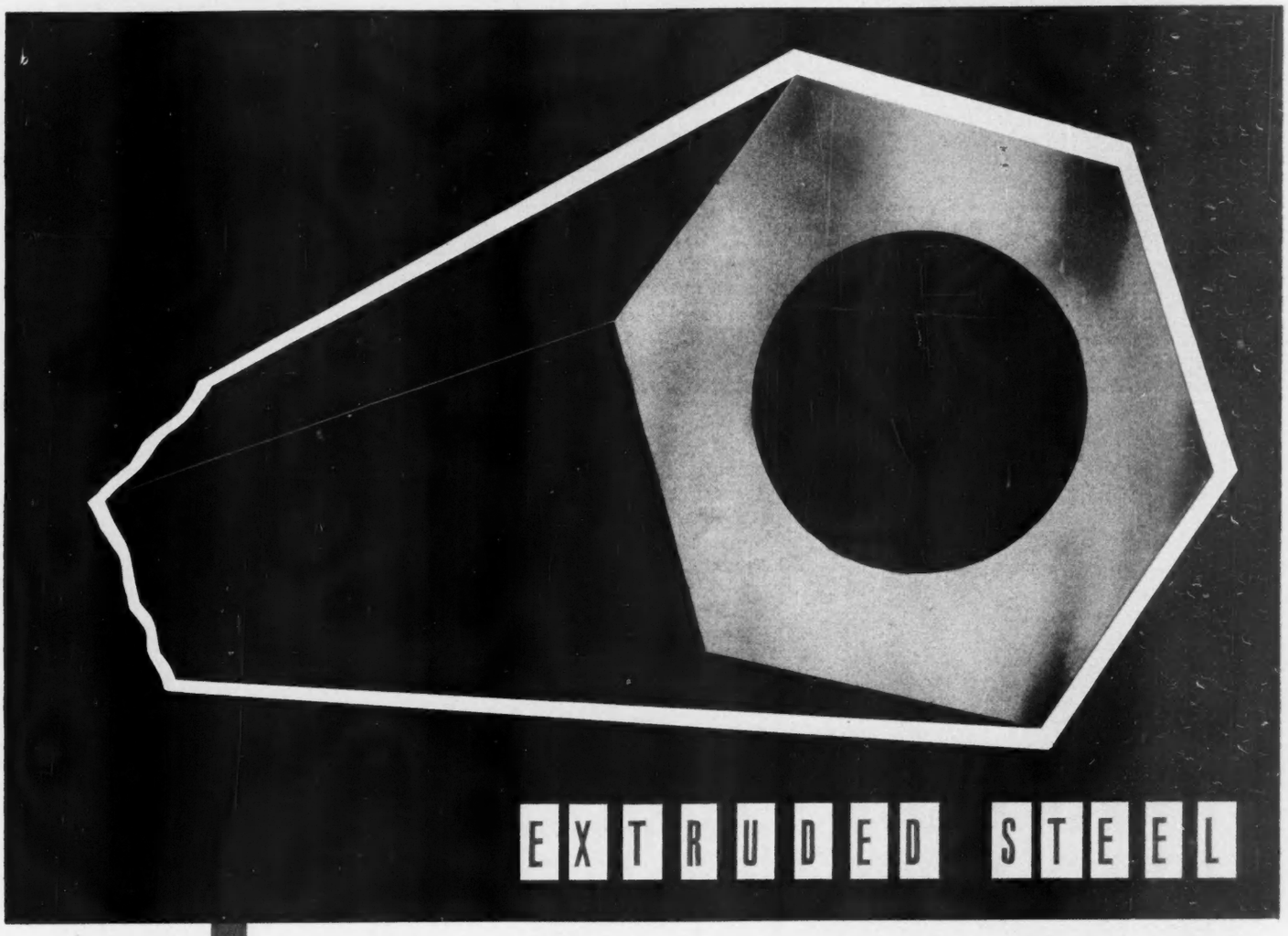

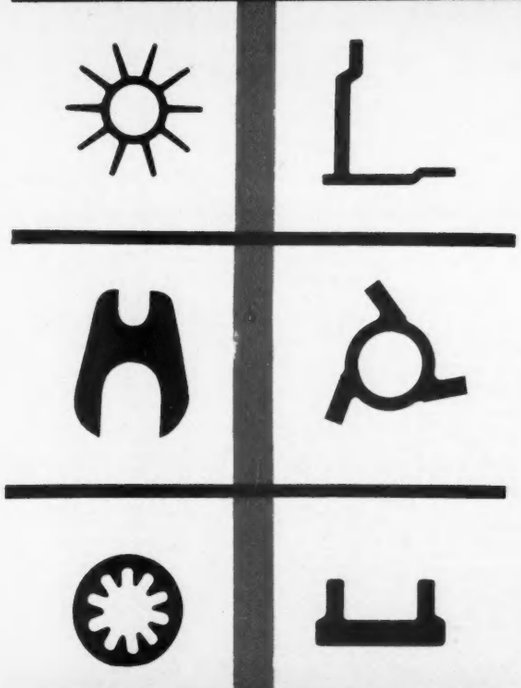

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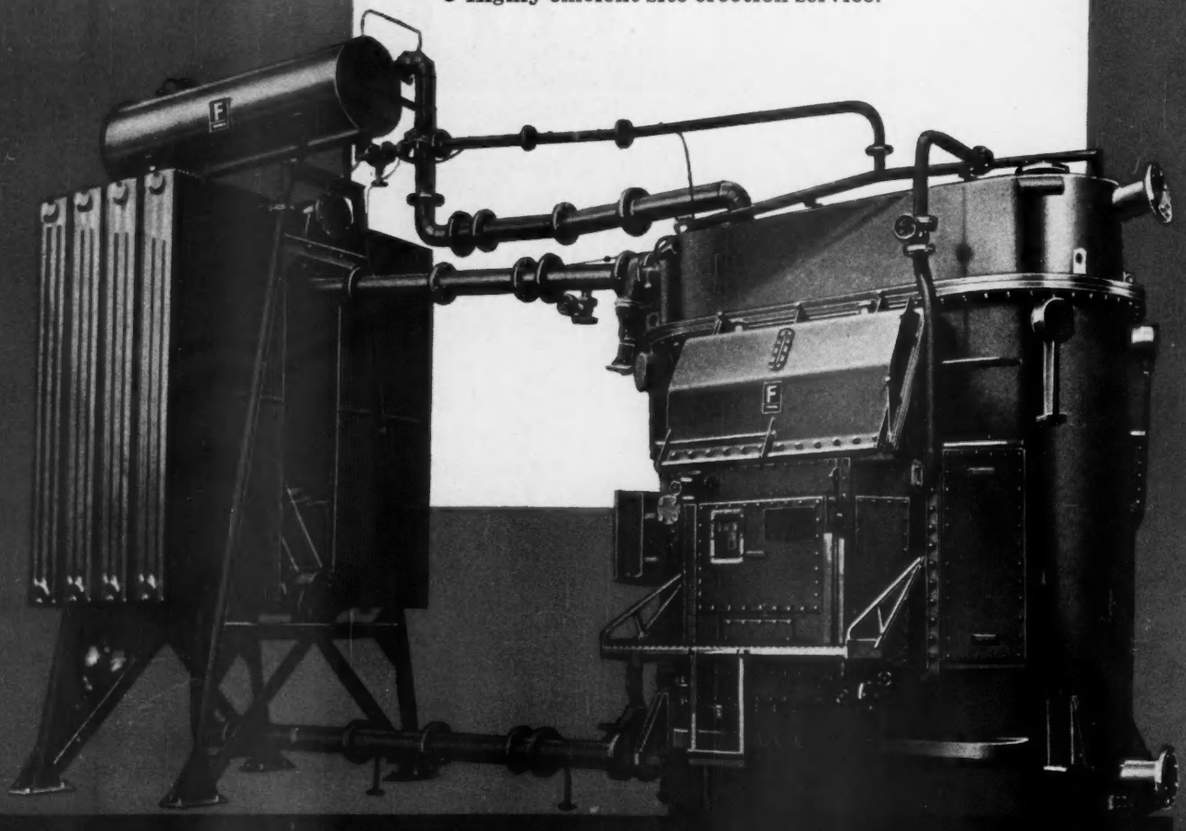

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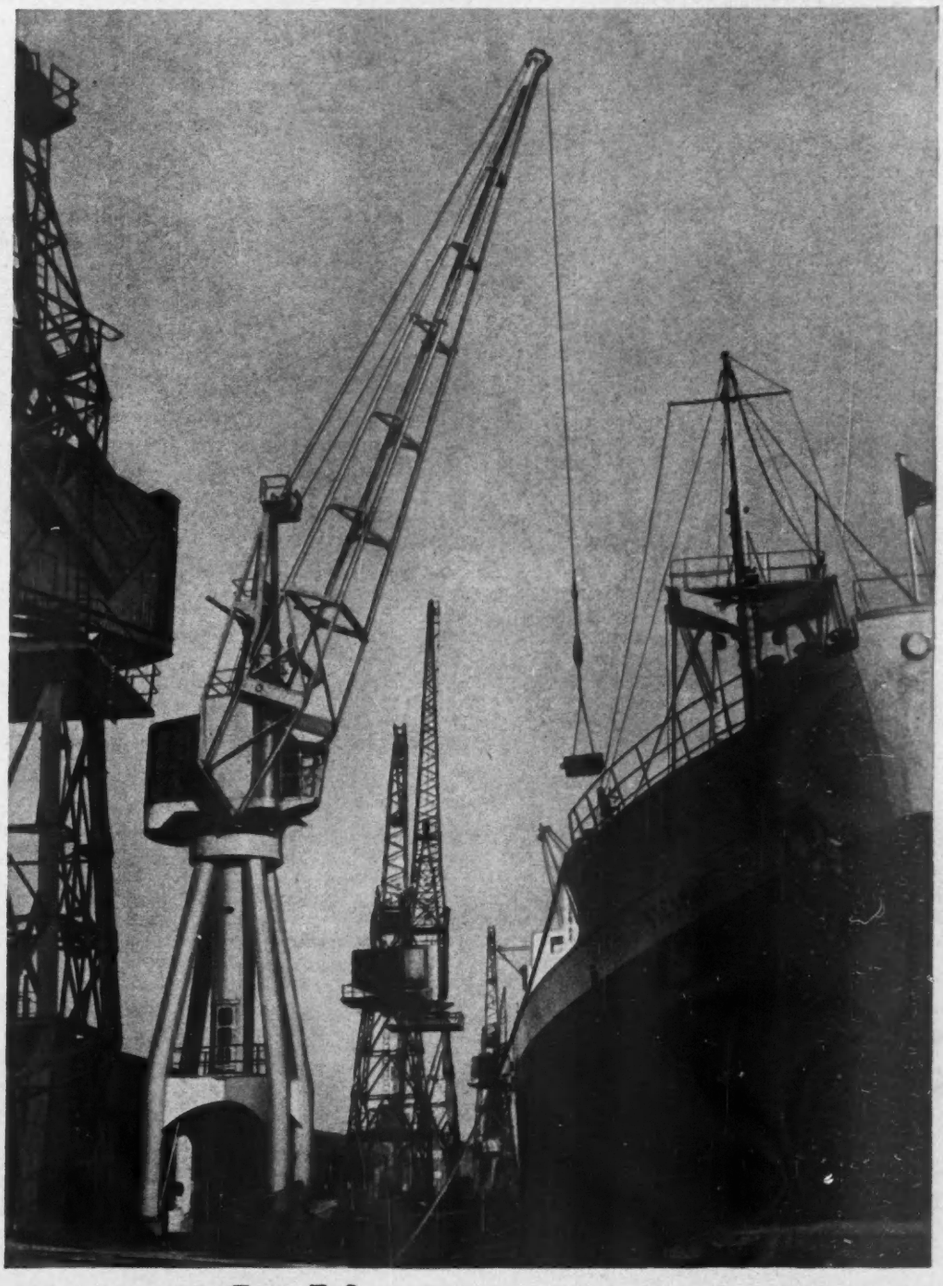

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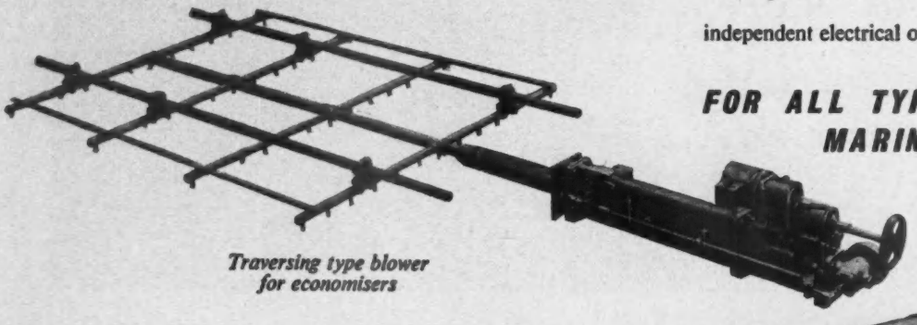
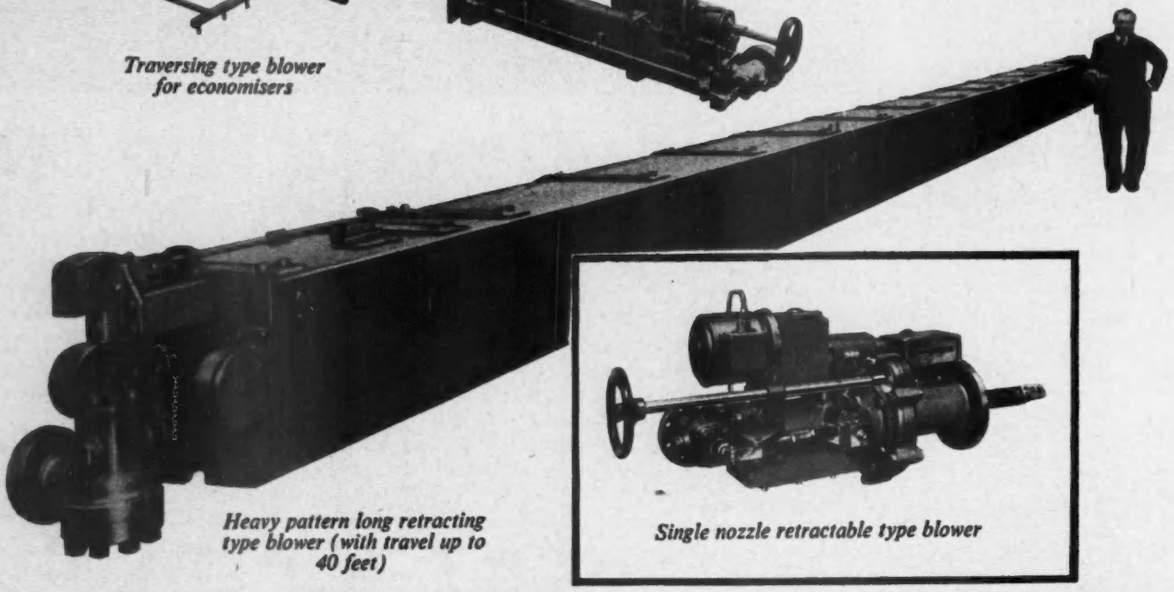


Traversing type blower for economisers



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Single nozzle retractable type blower

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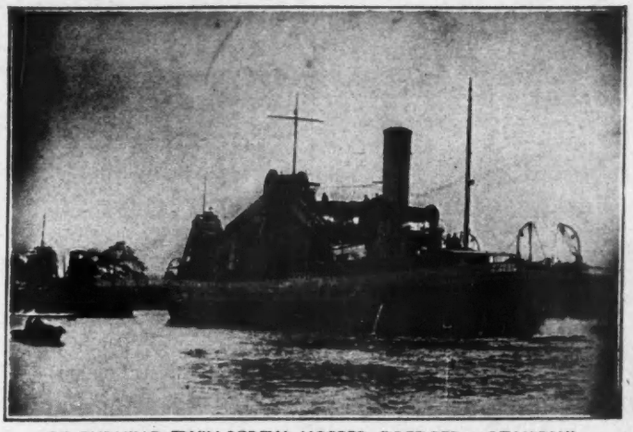

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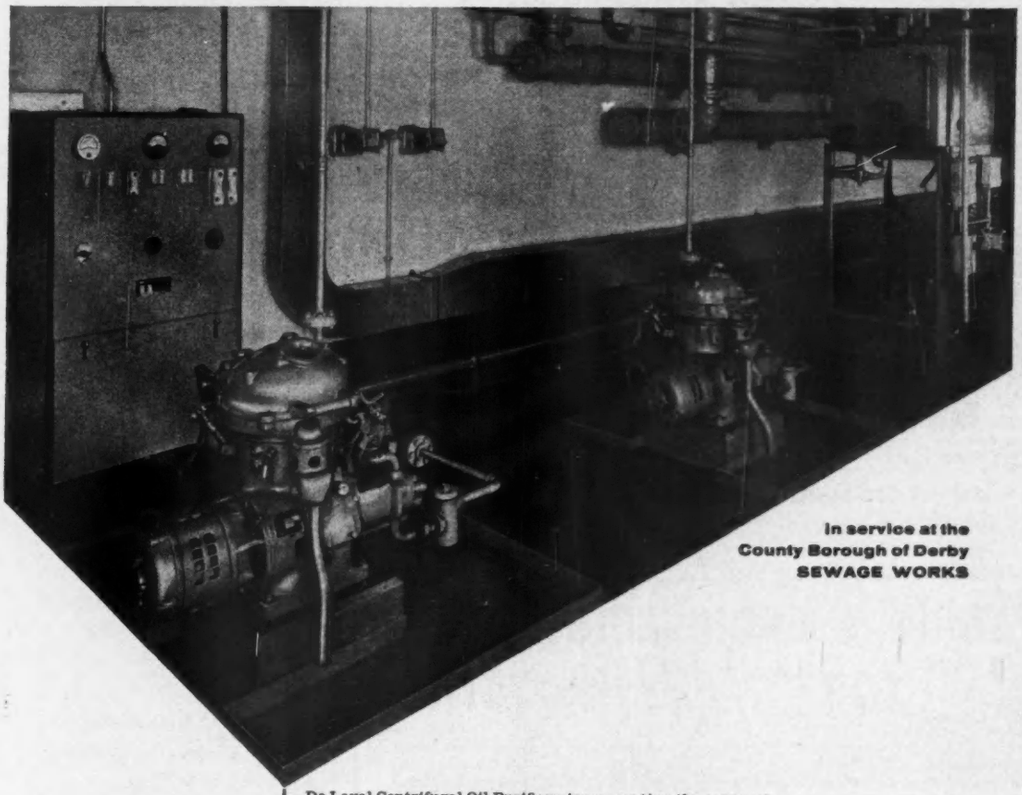

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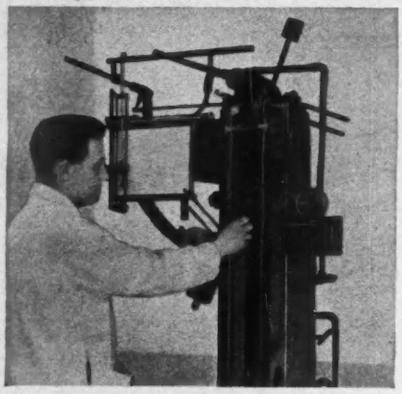

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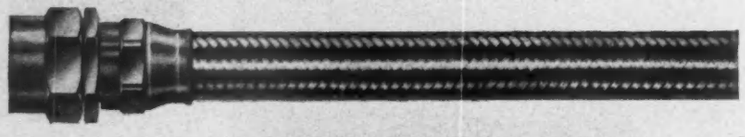

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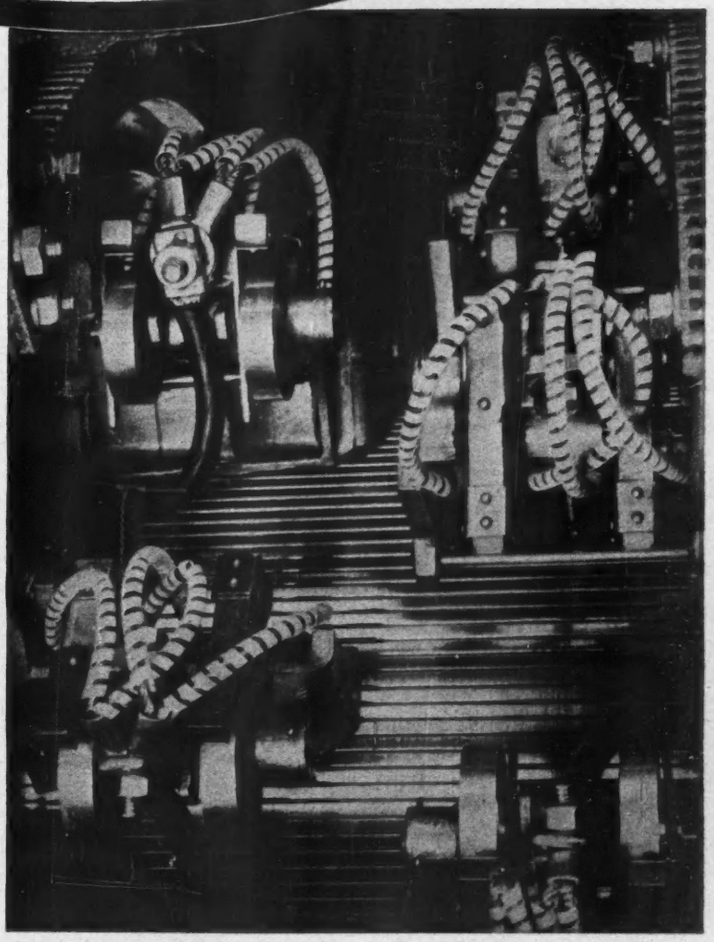

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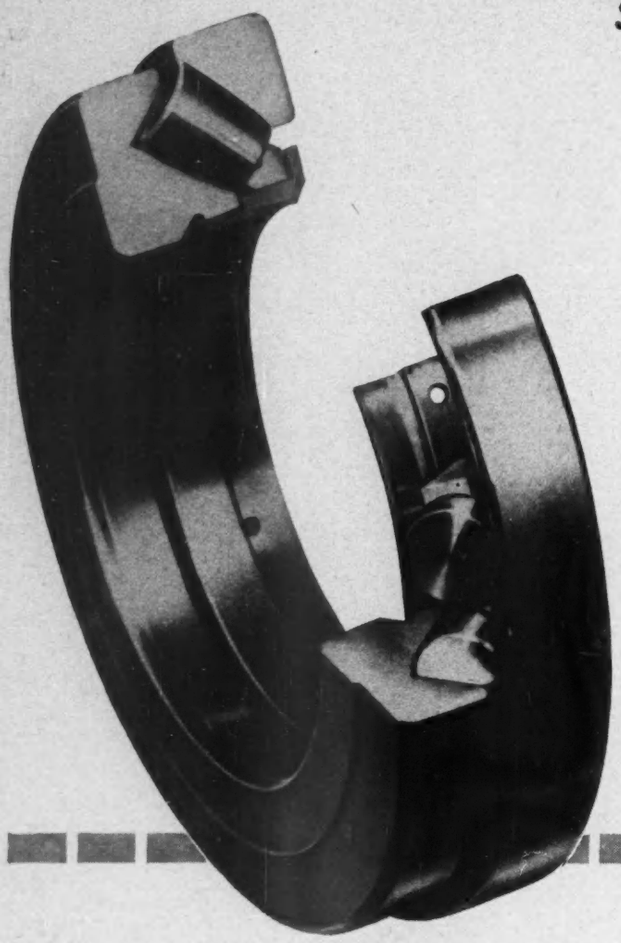
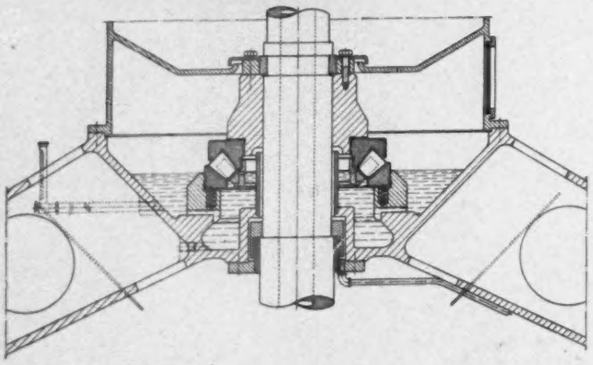
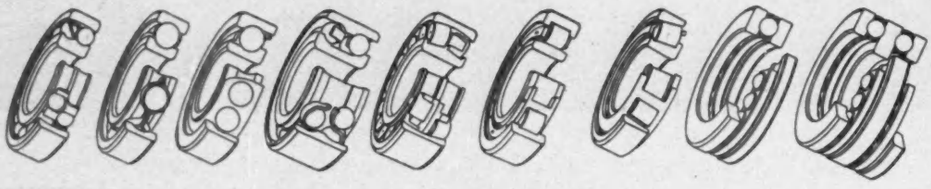


The spherical roller thrust bearing has one row of obliquely disposed rollers guided by a high flange on the shaft washer and running on a sphered track on the housing washer. It combines very high carrying capacity with complete self-alignment. The surface of the roller end next to the guiding flange is so formed that the rollers are always separated from the flange by an oil film when under load. The bearing can therefore be used at relatively high speeds, even if the load is very heavy. Unlike other thrust bearings, it can also carry radial loads.

Technical advice on the application of spherical roller thrust bearings, as well as other types of rolling bearings is always readily available from Luton or from any one of the twenty Skefko Branch Offices in the British Isles.



Support bearing for vertical electric generator



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ENGINEERING Impact

of Natural Gas and Increasing Production

THE United States has long freely been making use of natural gas on a major industrial scale. Now, as pipeline transportation of fuel becomes more and more of a current issue in the United Kingdom, it appears that Western Europe is already experiencing the first tremors of a continent-wide natural gas revolution.

The major question—whether the abundant North African natural gas is to enter Europe through Spain, the long way round, or through Sicily and into Italy, may in the end turn out to be not as important as it seems. The substantially increasing European resources of natural gas will sooner or later be supplemented, perhaps in equal quantities, from the Sahara. The effects on costs, production, even on physical comfort will be considerable.

One of the first effects is bound to be that the tentative cracks in the oil price front will become much more serious. The plastics industry for one, and a whole range of manufacturers in chemicals, are known to be interested in the greater purity so far experienced and the easier separation of by-products. Substantial operating experience has been accumulated in the United States, and in France and Italy.

Eventually London could well be on the Northern end of a great international natural gas pipeline starting in the desert and running through Italy or Spain, and through France to the Channel. The engineering problems of pipelines on the sea-bed have been well and truly solved in more than one application.

But more difficult than the technical are the political problems. Coal may not have the flexibility, or the other economic advantages, of piped natural gas, but it is mined by a substantial section of the British electorate (over 600,000 mineworkers). The large scale introduction of natural gas to Britain could hardly fail to depress the market for coal, which would leave the Government with the job of explaining that in the race to keep up with the productive abilities of our competitors some redeployment of peoples' jobs is unavoidable.

To be outside the European Common Market is bad enough. Not to have the advantages of a European natural gas grid could be very much worse.

Progress in Developing the Maltese Industries

Some months ago a fresh and lively flourish was given to announcing further endeavours to develop the economy of Malta. The island is secure in the history books for its efforts during the Second World War. With the departure of the Royal Navy from the famous dockyards it is not so secure in the business of earning a living.

It is pleasant to record that things appear to be moving on well towards diversified industries and greater local employment and therefore spending power.

£32 million is expected to be spent under the five year, 1959-64, development plan. In the recent House of Lords debate the Earl of Perth, Minister of State at the Colonial Office, was able to report that the new deep water quay, an important step forward in modernising the port, and the new silo will come into operation next year.

A first extension has been completed to the power station and a further extension is planned.

The Maltese authorities are making use of the usual tax inducements and special local arrangements that are currently used for the attraction of new industries, with the result that this assistance has been approved for the expansion of five existing firms and an hotel and for nine new companies and three new hotels.

Government assistance is in fact of the order of £750,000 towards a capital investment of about £3 million. The likely increase in the number employed will be between 2,000 and 3,000. Among the new businesses which are setting up, or to set up, on the island, are car assembly, light engineering, flower cutting propagation and textiles.

In addition to its highly adaptable population and useful position across the Mediterranean sea routes, Malta has, of course, a splendid climate. The exploitation of this advantage is being intensified with an active publicity programme.

Prosperity in Lancashire Engineering

Concern at the drooping prospects for the continued electrification of the London Midland Region's route between Lancashire and the capital naturally leads to the question, how are the industries of the North-West making out?

And the answer, a mixture of cotton prospects and the future of the heavy electrical firms, partly depends on the improvement of the rail service and partly hangs upon the continuance of employment in the electrical firms which will be jeopardised if the London-Crewe electrification should be abandoned.

The cotton industry still provides jobs for 200,000 people, despite fierce overseas competition and declining export figures. At home there have been some encouraging patches in demand but the ever-present bogey of imported cottons prevents any lasting solace for the home market.

Heavy engineering, as has been commented upon already, is extremely busy. The greater part of the work in hand is on orders booked months ago. So it is important to look into the current order position with a view to what the state of activity will be in a year's time.

This is not so promising. New orders have fallen a little, but there remains the possibility that the rate of demand for the heavy engineering industry's capital goods may pick up to its high levels of a few months ago. If it does so with sufficient speed then there need be no decline from the present busy state of the workshops.

The chemical and pharmaceutical interests, grouped along the Mersey and also along the river bank further back from the sea, are meeting heavy demand, a high proportion of it from abroad. Between 60 and 70 per cent of the output of the heavy engineering industry is exported and there is at least one chemicals firm in the North-West which sends 90 per cent of its products to foreign consumers.

Something of the area's prospects in the middle distance at least depend upon a very far off function. This is the Moscow British Trade Fair next spring. The list of Lancashire companies who will be exhibiting there is long and varied. It takes in machine tools, asbestos, electronic equipment and textile machinery among many others.

Not surprisingly that part of the industry in the region which is concerned with consumer goods is hoping that the New Year will bring fresh demand for their products.

of Fresh Initiative in the Shipyards

Will the report on "Research and Development Requirements of the Shipbuilding and Marine Engineering Industries" have a profound and beneficial effect on those industries in the future?

The report was not asked for by the industries; it was prepared at the behest of a Government agency—the Council for Scientific and Industrial Research. The nationalised industries are accustomed to examination by Government and Parliament, but the private sector of the economy is generally left to go about its business. The shipbuilders and marine engineers of Britain might prefer to be left to themselves, too, but a carrot is dangled in front of them in the shape of a recommendation in the report that the Government should consider giving financial assistance to the industry. First, to help the industry's research into production techniques and methods; secondly, to award development contracts. Further studies of the industry's technical and economic problems by the Government's Department of Scientific and Industrial Research are also recommended.

Enterprise

If the report is generally accepted by the Government, after discussion in Parliament, it will mean that initiative and enterprise in one of the major engineering industries of the country are transferred in part from the industry to Government departments, notably the DSIR. The membership of DSIR committees is itself drawn from many industries, and thus the DSIR has the benefit of advice from some of the best scientific, technical and commercial brains in the country.

The chain of communication between DSIR committees and the engineers in the shipyard is likely to be long and tortuous. It is unlikely to foster that increase of initiative for which the Government are looking. Is there, then, no other way of putting fresh heart into the industry, at a time when—to quote the report—the world shipbuilding industry is facing a major and probably prolonged recession? If the world shipbuilding industry has collectively made the mistake of investing in far too much capacity, why pour public money into developing the British industry? Public money is earned entirely by the profitable industries of the country. Should those industries devote part of the wealth they have produced to revitalising an old industry which has fallen on hard times? It may be considered better for the nation to reserve the main effort of Government support for those industries which have a brighter future.

This question has not been considered by the committee; it was not part of their function to do so. But it will need to be considered before any action is taken.

and Local Broadcasting upon Industry

The excitement in the radio industry is very nearly up to eve of commercial television levels. And it is not connected with the approach of Christmas and whatever benefit the present giving season may bring to sales.

The more potent cause of all the hopeful anticipation is that before too much of the New Year has elapsed there will be something definite on the future of local commercial sound broadcasting in the United Kingdom. Something definite which would, for instance, get Pye under way with selling local "packaged" radio transmitting stations for round about £15,000 a time.

As in the United States and parts of the British Commonwealth, but definitely not in Great Britain, there is long experience of the small local radio station. Mostly they pour a steady stream of canned music onto the air, in the main to listening housewives for whom the background of music to the daily round grows more and more a habit.

Swift Reaction

Commercial possibility, and some United States local stations lead very healthy financial lives, enters with the simple fact that the stations broadcast to a strictly local audience. Listeners can react to an advertisement for something at the grocers or a new film at the local cinema by slipping on a coat and walking round the corner.

From local newspapers and local councils, all the way to a West of England wine firm and the Rank Organisation, people and organisations have been registering companies against the day when they have the chance to put music, local programmes and advertisements on the parochial air.

Apart from the sale of much more specialised broadcasting equipment, and the filip to the radio receiver sales, would local radio stations mean anything else to industry?

Human Relations

The chances are that they would. Growing importance is attached by firms of all sizes to human relationships, to the workers identification with his firm, even in some cases to his family's interest in his job. Inevitably the labour relations coverage of the national media, whether newspapers or television, tends to treat mainly of strikes and wage claims. Intelligent use of local broadcasting by the company executives, and for that matter the union officials, or works and offices within the area of the broadcasting station, offers an unusually attractive way of avoiding troubles and disputes arising basically out of nothing more than failure to exchange ideas.

Nuclear Graphite Offered Commercially

Impermeable graphite of the type made for nuclear fuel cans is now on the UK market. It is costly but will extend uses of resin and metal-impregnated grades towards higher temperatures.

COMMERCIAL graphites withstand high temperatures in non-oxidising conditions and resist the action of many corrosive gases and fluids. Unfortunately, the nature of the chemical changes they undergo in production makes them porous to both gases and fluids, without exception. There are several ways of making graphite or carbon impermeable, but only three have so far yielded commercial products. A fourth is in the offing.

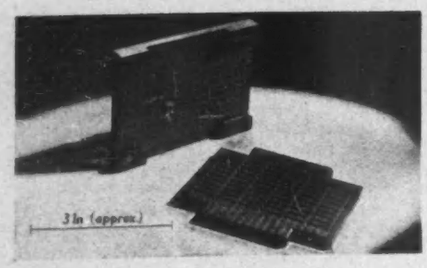
Two of the established ones are resin impregnation—such as with furane resins—operated by Morgan Crucible for chemical resistance at low temperatures, and metal impregnation to give improved strength in bearing materials. These processes admit the fact that making an impermeable all-graphite product is very difficult, and say, in effect, that a non-graphitic filler is needed. The third is what this article is all about—the process developed by RAE, Farnborough, now put into practice by Hawker Siddeley Nuclear Power Company, in which the final material is all-graphite. This third process depends on impregnation with materials such as furfuryl alcohol which is subsequently graphitised. In the offing is the pyrolitic method, which is being seriously considered by Morgan Crucible Company for commercial development, also Raytheon Company in the USA are said to be operating a pilot production facility in Lawrence, Massachusetts, for articles with a maximum dimension of 12 in using this process. Hawker Siddeley condemn the pyrolitic material as "exorbitantly expensive and anisotropic"; but then they have vested interests in their own process.

How it's Made

The method used by Hawker Siddeley for making impermeable graphite is not new in its basic idea. It involves liquid impregnation of carbon or graphite, followed by curing, carbonising, and usually by graphitising. Thus it's analogous with making high density graphite by liquid impregnation with an organic material such as coal tar followed also by curing, carbonising and graphitising. The only difference in the further pyrolytic method is that graphite is taken into the pores as a gas instead of a liquid and is then broken down to carbon by heat. Pyrographite, made by Raytheon, is unusual in that *all* the material is produced by breaking down hydrocarbon gases by heat, which under some circumstances is a method which can be made to build up a solid body suitable for graphitising.

Union Carbide and RAE both worked on the furfuryl alcohol process before Hawker Siddeley undertook to develop full scale plant. It is attractive because two impregnation cycles decrease permeability by factors of the order of 10^6 and strength is doubled in most stocks. Hawker Siddeley subsequently developed two further "goos" which they defy anyone to analyse within ten years, and which operate in a similar way. All three liquids are used in making products and the firm are prepared to sell their liquids with know-how. It is lamentable that after a flying start in which the process was widely discussed (see this journal, for instance, 22 Jan. '60, vol. 189, pp. 110-11 for an article on the furfuryl process) Hawker Siddeley should be back with a secret mixture like the rest of the industry, but at least we have a new end product—an impermeable, all-graphite, high strength material which is commercially available.

Experimental mouldings for a fluidised bed application.



The last sentence should be clearly registered, for this is the key announcement. Having erected two furnaces for making graphite by their process, Hawker Siddeley find they have spare capacity and are going commercial. Now this raises important questions such as cost, service to the customer, and what the effect will be of the firm's taking on nuclear agreements.

What it Costs

Total cost depends on the end product as the price of basic graphite ranges between £300 and £1,000 a ton and machining can be expensive. But treatment cost for a single impregnation and graphitising cycle is nearly constant per unit volume of material treated.

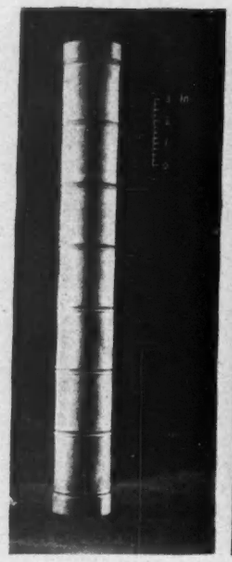
The factors involved will probably take the edge off using the material like resin impregnated grades as a cheap substitute for metals (for example, tantalum and titanium in chemical plant handling acids).

Hawker Siddeley's present facilities include a carbonising furnace and a graphitising furnace, which are roughly matched in throughput at 100 tons a year. The first of these has been in operation for 9 months; the second will come into operation probably next year if all goes well.

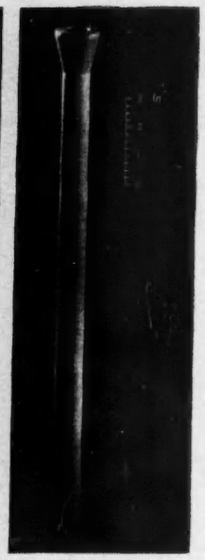
When it comes to their service, articles can be accepted up to 4 ft 6 in diameter by 14 ft 6 in length. A single impregnation cycle takes about a week and requires no preparation other than machining. The company will arrange for this to be carried out either before or after impregnation and it would normally be well worth while telling them the end use so that the firm can work out what the starting material should be, how many impregnations need be performed, and whether graphitisation as well as impregnation is desirable. Often it isn't.

The company certainly expect to supply cans for high-temperature, gas-cooled reactors but are reserving capacity for commercial use. If the firm run into difficulties in interference with established orders, they could easily install more facilities with a delay of about 12 months, or could have non-nuclear grades—still with low permeability—made by an outside firm using their liquids and know-how.

Examples around this page show the few early applications almost in their entirety. But it's only the beginning. It seems well worth while evaluating the material in chemical heat exchangers in place of the resin impregnated type which has a top temperature limitation below the 200° C mark. The material's lubricating and abrasion resistant properties have not yet been evaluated so this could apparently be done to advantage by makers of glands and seals, who might hit on a useful application earlier than otherwise. Certainly in erosive conditions the material is far better than previous ones. This is illustrated by use for transistor jigs and brass casting moulds which all resist wear in contact with molten metal. The outlet for rocket throats is undoubted, but is unlikely to stimulate other uses and will take only small quantities in its own right.



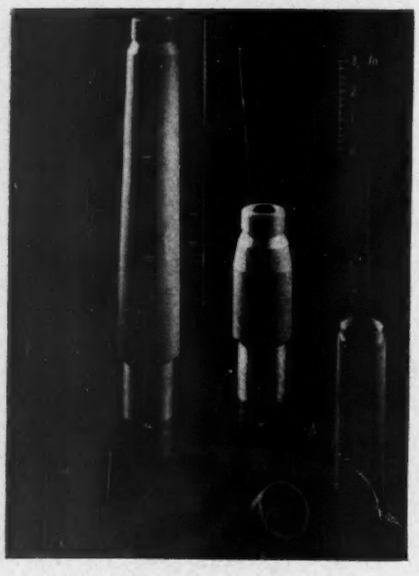
(*Left*) *Tube which holds specimens in pile-irradiation experiments.*



(*Right*) *Spout for casting brass and copper alloys. Erosion resistance is good.*

(*Above*) *Crucible for melting reactive and precious metals. A large potential outlet.*

(*Below*) *Dragon Reactor components. These are end plugs and fuel boxes.*



Spherical Powders

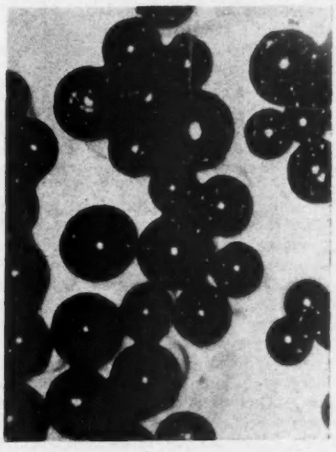
A process for producing spherical powders of metals and metal alloys with particles ranging in sizes from 20 to 150 microns has been developed by Union Carbide Corporation in the USA. Produced in a totally inert atmosphere, the tiny particles are free of such defects as voids, cavities and inclusions.

A total of six different powders are now available in limited quantities. They are copper, aluminium, nickel, 18Cr-8Ni-stainless steel (316), tungsten and Nichrome. A development programme is also under way on products with a particle size below 20 microns.

No prices are quoted for the pleasure of obtaining near-perfect spheres in these metals, but if this is only a few per cent on top of the cost of, say, the wrought material, some of the following comments by the makers may hold water.

Spherical powders, say Union Carbide, will find applications, in the main, which can take advantage of their uniform spherical shape. For instance, such powders may be used to fabricate sintered bodies requiring controlled porosity. This suggests usage in filters, burner plates, sweat cooled nozzles, and porous piston rings. The addition of from 10 to 20 per cent of spherical particles may improve the flow of angular particles into moulds and better the quality of sintered powder parts.

Highly reactive powders may be handled with less hazard when they are spherical in shape. Zircalloy II has been converted into powder by production under inert conditions and it is



likely that the process will be suitable for other such materials.

Union Carbide International Company, 30 East 42nd Street, New York, USA.

Quick Setting Strain Gauge Cement

British Sarozal have now introduced a rapid setting strain gauge cement into the United Kingdom. It comes from Germany. This material, known as X60, is an adhesive made for the specialist application of sticking strain gauges, so there's little point in expecting other applications. For those working in this field, X60 consists of a powder and a volatile, inflammable liquid which sets ready for static measurements in 30 min ; for dynamic measurements this is reduced to 20 min setting time.

The maximum operating temperature when used for static measurements is in the region of 100° C but it should be possible to use it dynamically even higher than this when plasticity is of less importance. It can be overheated to 180° C without harm.

Excellent bonds can be made to glazed porcelain or polished glass, according to the makers, but there are some plastic materials to which it will only bond after surface roughening. It is no good with polyethylene. There are several solvents which attack the cement for removal.

British Sarozal Limited, 22 Berners St., London, W1.

Wood Filler for Expansion Joints

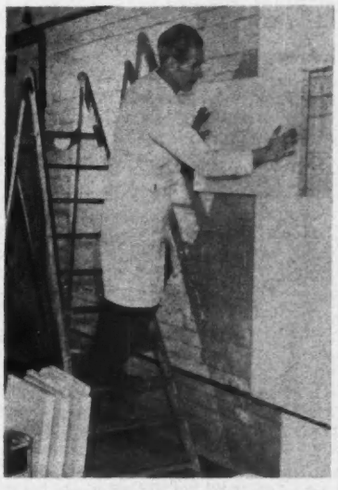
What is claimed to be the first 1 in thick homogeneous wood fibreboard expansion joint filler to be made in Britain is being marketed by Powell Duffryn Timber Industries under the name PD Resilex. It can be supplied in thicknesses of $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in to meet the demand for various joint thicknesses in road and concrete constructions, and as an anti-vibration agent for machinery. Besides having good wet strength and weathering properties, the makers claim that the board will not delaminate.

Standard widths are from 2 to 48 in, and standard lengths are from 4 to 10 ft. It complies with Air Ministry specification 201/58, and while it is readily compressed and will recover after compression to fill the joint, it is non-extruding.

Powell Duffryn Timber Industries Limited, Cardiff.

Adhesive and Sealer for Foamed Plastic

Polybond have perfected an adhesive system for foamed polystyrene panels, as marketed by several companies. It is based on their Polybond pva universal adhesive. The method is to prime the polystyrene section with adhesive



and then to make up a cement which contains equal parts of adhesive and cement together with a small amount of water. Panels are then spotted with this cement mix which remains plastic for final positioning for up to 10 minutes after first touching the surface. The cement readily adheres to a wide variety of surfaces, expecially brick, concrete or plaster, and no harm is done by moving the panels about for final positioning.

Polybond Limited, 130 Crawford Street, Baker Street, London, W1.

Clad Polyethylene Containers

Polyethylene containers for chemicals need protection during transit. But once the decision has been taken to use such a container and to protect it with a crate or box, there is a derived benefit in that wall thickness (compared with clear standing containers) can be reduced. This idea has progressed to the point where some firms have tried making containers out of polyethylene bags inside boxes. The main difficulty in this is provision of a pouring spout and closure.

Look now at the illustrations below. One at the top is a streamlined clad container made by Reed Corrugated Cases. Great strength and rigidity are notable features of the pack, which has four thicknesses of heavy board at the top and base and double thickness on the four walls. The polyethylene vessel is manufactured by the new company, Reed Plastic Packaging, and is a lightweight thin-walled vessel of one-piece seamless construction. Its integral screw-necked filling and pouring aperture has been designed to avoid spillage when dispensing even very small quantities of the contents. The first size is 5 gallons, and this will be followed by others. They're intended to be non-returnable.

Replacing fibreboard with plywood, but using the same basic idea, has lead to acceptance of this form of packaging by H. P. Bulmer and Company, the cider makers—this time for returnable packs. Use of a plastic container has

avoided one of the major problems encountered when wooden casks were used—the fact that highly-sugared fruit concentrate draws moisture out of the wood with which it is in contact. Cascelloid Ltd. blow-moulded the containers in high density polyethylene, and Bulmers find they will stand up to sterilising operations such as 1½ per cent detergent at 160 to 180° F. In quantity, the casks cost 40 per cent less than the 10 gallon ones they replace. The 6 mm plywood made by Venesta Plywood and used for the outer box seems to withstand rough handling quite satisfactorily, and nearly all the containers supplied under Bulmers' original pilot order in 1956 are still in service today.

Albert E. Reed and Company Limited, Kew Bridge, Brentford, Middlesex.

Venesta Plywood Limited, Queen Street Place, London, EC4.

Plain Words

By Capricorn

NEW words are created faster than is comfortable for the average man (bless him). He is under no compulsion to learn them but he is embarrassed when one of them crops up in conversation. If he is not quick to admit his ignorance, he may find himself in very deep water.

If he says straight away " What does that mean?" he may look foolish or ignorant for a moment, but if he pretends he knows all about the thing, he may regret his vanity. His informant goes on talking, while he has lost any frame of reference he may have had at the beginning of the conversation. He longs for the telephone to interrupt them; in extreme cases, when he is in front of a Very Superior Person, he wishes that the floor might open up and swallow him.

There are other occasions when one can take a secret pride in not knowing the current jargon. It's too specialised for me, you say to yourself. I am an administrator, or I am a specialist in something else, or it is my job to retain a broad view. That is how I felt when I was talking recently to an engineering professor and was unable to conceal my ignorance of a rather high flight of theory which he wanted to discuss. He was only too obviously pleased with his ability to juggle with these things as nimbly as I can check the change a shopkeeper gives me. He as good as said that I ought to be ashamed of myself for not knowing about these things. That was not very tactful of him. I comforted myself with the thought that I knew lots of things he didn't know, and I wanted to turn the conversation on to my specialism, but as it had no precise theoretical content I knew he would not be interested. Ignorant bounder !

Forgive me if I appear to assume too readily that you are like me in this respect. Perhaps you are a real demon for new words and new ideas. Then you would enjoy the appeal lists which the Editor of the *Oxford English Dictionary Supplement* issues periodically. He lists words and the earliest known quotations in the collections at Oxford, and he invites your cooperation in giving earlier references. You will find moped (1956), method study (1959), flow sheet (1954), fly ash (1954), glove box (1958), kibbutz (1946), in-tray (1943), include out (1938), hot rod (1945), mousetrap (i.e. cheese, 1947), and thousands more. Many of the words come from science and engineering. Who, I wonder, invents them?

But I am not over-worried about my ignorance. It seems to me that there are plenty of people in the world who are adding knowledge at too fast a rate. I find it is better to absorb and apply knowledge which has been kicking around for some time. Knowledge which has been refined and generally sorted out but has not yet been fully applied. Since few folk bother to do even that much, you should do very well thank you in the 1960's if you set about applying the findings of the 1950's.

Letters to the Editor

Contracts by Model Form

SIR, It was with great interest that I read Mr. F. H. B. Layfield's article " Standard Forms Aid Overseas Contracting " (ENGNG., 19 Aug. '60, p. 240), and I feel sure he is right in welcoming the new edition of Model Form B2 prepared for the Councils of the Institution of Mechanical Engineers and the Institution of Electrical Engineers.

He has once again underlined two of the great problems of contract, namely what documents form part of the contract and what happens when there is a conflict between standard terms and terms written into a standard form.

Nonetheless, however excellent the standard form, I think there are dangers to lawyers and engineers alike in leaning too heavily on the form and failing to redraft provisions to fit the particular project or territory. Those who cling too closely to standard forms because they are reluctant to redraft, are those least likely to appreciate the unsuitability of provisions in standard forms. Paradoxically, only those who do not need to use standard forms can use them with reasonable confidence! However, as an *aide-mémoire* to the essential provisions of contracts and as a guide they are an immensely useful tool.

Yours faithfully,
R. M. A. BRAINE,
Managing Director.

Conforex Limited,
London, EC3.
9 December, 1960.

Mixing Gases

SIR, In his second letter on the problem of mixing gases Dr. E. A. Bruges (ENGNG., 2 Dec. '60, p. 755) gives a correct expression of the relation between the available energy and the entropy of a system; but I am sorry to add that this well-known expression is the only part of his letter to which I can agree.

Dr. Bruges assumes that I am in two minds about the question whether there is an increase in entropy when two gases mix or not. As a matter of fact, my position is quite clear: I believe that there is *not* an entropy increase in this case. Thus, I wrote in my letter (ENGNG., 4 Nov. '60, p. 600) that " for the engineer, the entropy change (which is proportional to the change of available energy) is zero, not only when the mixing gases (under constant pressure and temperature) are identical, but even when they are not."

When I add that the same entropy increase is an artificial and useless conception, even from the physicist's point of view, I don't think that I change my mind in doing so, but, on the contrary, that the second conclusion only confirms the first one. More precisely, the modern theory of information shows that there *is* an increase of entropy in the case of mixing gases, but this increase is a function of the nature of the gases and, accordingly, has nothing in common with the entropy increase mentioned by Dr. Bruges.

Dr. Bruges asserts that " we all know " that the entropy increases and, accordingly, that the available energy decreases. But the comments on my article show, on the contrary, that at least some engineers do not share the opinion of Dr. Bruges: they know that the available energy *does not* decrease and that its constancy *does not* contravene the Second Law.

In the opinion of Dr. Bruges, there are " many other errors of principle " in my article; as this statement is gratuitous, I am not able to reply to it. But when Dr. Bruges says that I " confess" that my discussion is for 1 lb of perfect gas at rest and that in this case my analysis is wrong, he gives a very personal interpretation of my letter. Of course, the available energy is always calculated for a gas at rest, and this assertion is by no means a " confession." The only thing I have to confess is that the discussion of a comment which is so short of arguments as that of Dr. Bruges seems to me to be entirely sterile.

But I think there is a possibility to find an issue from this situation: it is to ask Dr. Bruges a precise question. In his book *Available Energy and the Second Law Analysis*, Dr. Bruges shows (in chapter 5) by means of permeable membranes, that the mixing of two gases, each at the same temperature and pressure, leads to a decrease of available energy. The question is: does Dr. Bruges believe that the same decrease of available energy can also be proved without making use of permeable membranes? If he does, his proof will be an important contribution to the theory of mixing gases; and if he does not, we shall have reached at least a partial agreement.

Thus, any unambiguous answer will bring a new and interesting datum to our discussion; but, of course, an ambiguous answer will do it as well.

Yours faithfully,
P. CHAMBADAL.

Electricité de France,
Paris.
9 December, 1960.

Traffic Problem Solved?

SIR, Mr. A. Lassally's letter interested me, particularly his reference to " travelling roads " (ENGNG., 9 Dec. '60, p. 780).

In Mars this is a very old idea. It was tried out by a crank inventor over 3,000 of our years ago. Its use is now restricted to their penal settlement where its inefficiency is an advantage. Professor Kurd Lasswitz must have obtained the details from that penal settlement, which, incidentally, is the area on Mars where all lawless types and thugs are sent; the idea being that, provided only with primitive equipment, they must work hard to make a living. Further, by being isolated from the law-abiding society they can no longer impede its progress by interfering with it.

The modern transport in use on Mars today is three dimensional. During their last war (which was atomic), they discovered that so much of their atmosphere had been blown off the planet by atomic explosions, it was no longer possible to live on the surface without pressure suits. They converted their underground war-time shelters into pressurised cities. These are now very beautiful.

The largest cities may have 200 or more stories or layers. Their traffic is as much vertical as horizontal. All long-distance passenger transport is by jet planes; these emerging from the underground cities through air locks. The need for long-distance goods traffic is small, but some short-distance conveyors are in use in some parts for such goods. These are ejected from the conveyor electronically at their destination.

To adopt the Martian system in this country would be impossible since our extra gravity would create strength-of-building problems which they do not have to face.

Yours faithfully,
L. M. T. BELL.

Petersfield, Hants.
9 December, 1960.

Bent Shafts

SIR, Regarding the article on " Unbalanced and Initially Bent Shafts " (ENGNG., 25 Nov. '60, p. 735), I do not understand what the author—Professor R. E. D. Bishop—means by his claim that it has proved possible to relax Jeffcott's idealisation of the massless shaft with offset massive particle and that such (Professor Bishop's) process leads to a distinction between the two cases; namely, (*a*) unbalanced shaft and (*b*) initially bent shaft.

Actually, in the circumstances envisaged by Jeffcott, there is no distinction. In his case

(*a*), Professor Bishop has assumed (as in the customary treatment) that the viscous damping acts at the geometrical centre of the axis of the shaft, whereas, in his case (*b*), he has assumed the damping to act at the centre of gravity of the mass. If, in the former case, the damping is also assumed to act at the centre of gravity of the mass, the corresponding results will be exactly the same in both cases.

Thus, if, in Professor Bishop's Fig. 1, reproduced below, we arrange for the damping $b\,r\,\Omega$

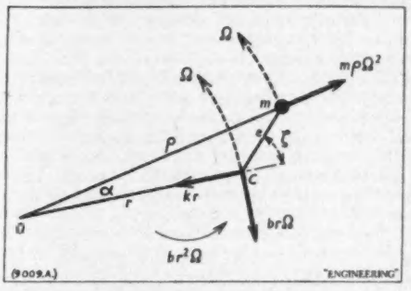


Fig. 1 Forces acting on a thin slice (not shown) of the light shaft at the section at which the offset mass is supposed to be placed.

to act at m and at right angles to O m and if, further, we write ρ for r and r for ρ, we obtain precisely the same results for the two cases.

It is through his confusion on this aspect that Professor Bishop obtains the anomalous result (10) for his cases (*a*) and (*b*) combined.

Yours faithfully,

JOSEPH MORRIS.

Guildford, Surrey.
11 December, 1960.

Events in Advance

Young People's Christmas Lectures

FOR a number of years now, there has been a striking increase in the number of professional institutions which set out, at Christmas time, to provide popular lectures intended to appeal mainly to boys and girls between 10 and 17 years of age.

A few of these lectures—the list must necessarily be selective—are referred to below. All those mentioned will be held in London. Applications for tickets should be made promptly and should be sent to the secretaries of the institutions concerned at the addresses given. No charge is made, except in the case of the Royal Institution, and in most cases tickets are obtainable for adults wishing to accompany the children.

Institution of Civil Engineers

"Man-Made Satellites and Space Navigation," by Dr. J. G. Porter and G. K. C. Pardoe, on Thurs., 29 Dec., at 3 p.m.; and "Surveying in the Antarctic," by A. Stephenson, on Fri., 30 Dec., at 3 p.m. At Great George Street, SW1.

Institution of Electrical Engineers

"Space Research by Rocket and Satellite," by Dr. R. L. F. Boyd, on Tues. and Wed., 3 and 4 Jan., at 3 p.m. At Savoy Place, Victoria Embankment, WC2.

Institution of Gas Engineers

"The Production of Fuel Gases," by C. H. Lewis, at the Imperial College of Science and Technology, South Kensington, SW7, on Tues., 3 Jan., at 2.30 p.m. Institution's offices: 17 Grosvenor Crescent, SW1.

Plastics Institute

"Plastics and Textiles," by Dr. H. A. Thomas, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, WC2, on Mon., 2 Jan., at 2.30 p.m. Institute's offices: 6 Mandeville Place, W1.

Royal Aeronautical Society

"Gyroscope and Pendulum," by R. J. Lees, on Thurs., 5 Jan., at 3 p.m. At 4 Hamilton Place, W1.

Royal Institution

"Seeing the Very Small," six lectures by Dr. V. E. Cosslett, on Thurs. and Sat., 29 and 31 Dec.; Tues., Thurs. and Sat., 3, 5 and 7 Jan.; and Tues., 10 Jan.; in each case at 3 p.m. Non-members' children £1 and adults £2. At 21 Albemarle Street, W1.

Royal Society of Arts

"The Legend of the Phoenix," by Dr. Maurice Burton, on Fri., 30 Dec., at 2.30 p.m.; and "Railways in Our Time," by C. Hamilton Ellis, on Wed., 4 Jan., at 2.30 p.m. Tickets are primarily restricted to the young guests of Fellows of the Society, but, in addition, a few are available for other children. At John Adam Street, Adelphi, WC2.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Automatic Techniques in Civil Air-Line Communications Systems," by W. E. Brunt. Radar Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 4 Jan., 6.30 p.m.*
BRISTOL
"Masers and Parametric Amplifiers," by Dr. W. A. Gambling. South Western Section. School of Management Studies, Unity Street, Bristol. Wed., 11 Jan., 7 p.m.

Engineers' Guild

READING
Inaugural meeting of the Western Home Counties Branch. Address by J. G. Orr, secretary of the Guild. Great Western Hotel, Reading. Thurs., 12 Jan., 6 p.m.

Illuminating Engineering Society

LONDON
"Modern Aids to Lighting Design: Computer Techniques," by H. R. Ruff, H. E. Bellchambers and G. K. Lambert. Federation of British Industries, 21 Tothill Street, SW1. Mon., 9 Jan., 6 p.m.
NOTTINGHAM
"Light Effect on Dyes," by W. L. Lead. Nottingham Centre. Electricity Centre, Carrington Street, Nottingham. Thurs., 5 Jan., 6 p.m.

Institute of Metals

BIRMINGHAM
"Vacuum Technology," by T. Thorley. Birmingham Local Section. College of Technology, Gosta Green, Birmingham. Thurs., 5 Jan., 6.30 p.m.

Institute of Refrigeration

LONDON
"The Use of Two-Stage Freezing Procedures for Eviscerated Chicken," by Dr. R. Gane and Dr. D. H. Shrimpton. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 5 Jan., 5.30 p.m.*

Institute of Road Transport Engineers

BRISTOL
"Air Brakes for Commercial Road Vehicles," by W. A. Kirk. Western Centre. Royal Hotel, Bristol. Tues., 3 Jan., 7 p.m.
EXETER
"Servicing of Electrical Equipment," by J. H. Stoneman. South Western Group. City Fire Brigade Headquarters, Exeter. Thurs., 5 Jan., 7.30 p.m.

Institution of Electrical Engineers

BIRMINGHAM
"Broadening University Courses": discussion to be opened by Dr. H. E. M. Barlow. South Midlands Centre. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Mon., 2 Jan., 6.30 p.m.*
EDINBURGH
Film Evening. South East Scotland Graduate and Student Section. Offices of the South of Scotland Electricity Board, Dewar Place, Edinburgh. Mon., 9 Jan., 7.30 p.m.
LEEDS
"Water-Turbine-Driven Induction Generators," by C. L. C. Allan. North Midland Centre. Leeds and County Conservative Club, South Parade, Leeds 1. Tues., 3 Jan., 6.30 p.m.*
NEWCASTLE UPON TYNE
"The Application of Electronics to the Electricity Supply Industry," by Dr. J. S. Forrest. Third Hunter Memorial Lecture. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 9 Jan., 6.15 p.m.*

Institution of Engineers-in-Charge

LONDON
"Modern Use of Fuel Oil," by G. E. Fenner. Caxton Hall, off Victoria Street, SW1. Wed., 11 Jan., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

BRISTOL
"Mechanical Services in the New Lloyd's Building," by J. R. Kell. South Western Branch. RWA School of Architecture, Bristol. Tues., 3 Jan., 6.30 p.m.
MANCHESTER
"Industrial Architecture," by W. A. Gibbon. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 10 Jan., 7.15 p.m.

Institution of Mechanical Engineers

LONDON
Discussion, arranged by the Internal Combustion Engine Group. Mon., 9 Jan., 6 p.m.*
CHELMSFORD
"The Investigation of Radio Sources at Jodrell Bank," by Dr. H. F. Palmer. Eastern Branch. Hoffman's Social Hall, Chelmsford. Thurs., 5 Jan., 7.30 p.m.
LEICESTER
"The Vibration of Vertical Milling Machines under Testing and Working Conditions," by Professor H. A. Tobias. East Midlands Branch. College of Technology and Commerce, Leicester. Thurs., 5 Jan., 7.15 p.m.
NEWCASTLE UPON TYNE
Chairman's Address. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 9 Jan., 6 p.m.
NOTTINGHAM
"An Introduction to Metal Fatigue," by E. A. Roberts. Joint meeting of the East Midlands Branch and the East Midlands Graduates' Section. Engineering Building, The University, Nottingham. Thurs., 12 Jan., 7.15 p.m.

Institution of Plant Engineers

EDINBURGH
"Heating," by A. A. Kidd. Edinburgh Branch. 25 Charlotte Square, Edinburgh. Wed., 4 Jan., 7 p.m.
LEICESTER
"The River Dove Water Scheme," by Hal. Wallhouse. Leicester Branch. Midland Hotel, Leicester. Wed., 4 Jan., 7.30 p.m.
PETERBOROUGH
"Future Railway Development in Peterborough and District": Discussion. Peterborough Branch. White Lion Hotel, Church Street, Peterborough. Tues., 3 Jan., 7.30 p.m.

Institution of Structural Engineers

BIRMINGHAM
"Precast Concrete Frame Construction," by Bryan E. Griffin. Midland Graduates' and Students' Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Fri., 6 Jan., 6.30 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., 30 Dec., 7 p.m.*
BIRMINGHAM
"Engineering in Chemical Works," by E. R. Brazier. Midland Section. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Wed., 4 Jan., 7 p.m.

Leeds Metallurgical Society

BRADFORD
"Some Recent Developments in the Welding of Metals," by E. N. Gregory. Bradford Institute of Technology, Bradford. Wed., 4 Jan., 6.30 p.m.

Newcomen Society

LONDON
"Joshua Gilpin; An American Manufacturer in England and Wales: Part II, 1811-1814," by Dr. Harold B. Hancock and Dr. Norman B. Wilkinson. Wed., 4 Jan., 5.30 p.m.

Reinforced Concrete Association

BIRMINGHAM
"Reinforced Concrete Construction in the Coal Industry," by C. A. C. Davies. Midland Counties Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 3 Jan., 6 p.m.*

Royal Aeronautical Society

LONDON
"Planning of Missile Acceptance Trials," by J. F. W. Mercer and A. R. Cawthorne. Tues., 3 Jan., 6 p.m.

Royal Institution of Naval Architects

LONDON
Third Amos Ayre Lecture, by A. Hunter. Thurs., 5 Jan., 4.45 p.m.

Royal Society of Arts

LONDON
"Ergonomics: Fitting the Job to the Worker," by Dr. C. B. Frisby. Wed., 11 Jan., 6 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Analysis Group's Annual General Meeting. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 10 Jan., 7 p.m.

Society of Instrument Technology

SHEFFIELD
"Instruments and Cherry Blossom—Some Impressions of a Technical Visit to Japan," by W. C. Heselwood. South Yorkshire Section. The University, St. George's Square, Sheffield 1. Wed., 4 Jan., 7 p.m.

South Wales Institute of Engineers

CARDIFF
"Strain Ageing of Mild Steel," by W. J. S. Roberts. Thurs., 12 Jan., 6 p.m.

Television Society

LONDON
"A Wide Range Standards Converter," by E. R. Rout and R. F. Vigurs. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, WC2. Fri., 13 Jan., 7 p.m.

Women's Engineering Society

LONDON
"Ground Effect Machines": Discussion. Hope House, 45 Great Peter Street, SW1. Wed., 11 Jan., 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Engineers' Guild, 78 Buckingham Gate, London, SW1. (ABBey 7315)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London, EC4. (CENtral 4694)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4304)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

How Much Longer Can London Survive?

Traffic congestion can be overcome by keeping the cities largely as they are and excluding private cars; or by rebuilding them. Either choice means the end of cities as they are today.

By R. G. Pay, M.Sc.

Christmas is coming,
The goose is looking well,
Traffic's at a standstill,
Oh, hell.

IT IS the season of goodwill that sees tempers at their shortest on London's streets. Then traffic congestion reaches its peak and provides a foretaste of what will be the normal daily condition when car ownership increases still further. Of course, attempts are made to keep the traffic moving. Apart from parking restrictions, there are the plans of the London Roads Committee to increase traffic capacity of the main routes in London by 50 per cent. Unfortunately the plan is for a 20 year period, the first half of which could see a growth of 100 per cent in the number of vehicles on the roads.

In a paper, "Car Ownership and Use," read by Alan Day before the Town and Country Planning Association, it is pointed out that since 1954 the number of private cars on the roads has increased by 60 per cent, and the mileage they travel has increased by 76 per cent. The author, a Reader in Economics at the University of London, sees no reason why the trend should not continue; so that by the end of the century—not a long time in the life of a road now being built—the number of commercial and private vehicles on the roads should be about 600 for every 1,000 people. We must, in fact, be prepared for an ultimate situation of 30 million motor vehicles in Britain, compared with 8·6 million at the end of last year.

If the number of cars is related to the rise in real income, then it should reach about 10 million in 1973 and about 20 million in the late 1980's. That is, he expects a doubling of private car ownership in about 14 years instead of the often-quoted figure of 10 years.

KEEP OUT CARS

The cost of traffic congestion for 1958 has been worked out at the Road Research Laboratory. In a paper "Economic Losses Due to Traffic Congestion," by D. J. Reynolds and J. G. Wardrop, the authors base their calculation on the facts that in 1958 some 33,000 million motor vehicle miles were travelled on urban roads at an average speed of 20 m.p.h., while some 27,000 million motor vehicles miles were travelled on rural roads at an average speed of 32 m.p.h. In very light traffic these speeds should be about 25 m.p.h. and 40 m.p.h. respectively. The slowing down is used as a basis for calculating losses. The authors show that the cost of congestion in Great Britain in 1958 was about £140 million in urban areas and £60 million in rural areas. The total of £200 million is about 10 per cent of the real cost of road user's transport and about 1 per cent of the net national income. The rate of increase of the cost of congestion is calculated to be more than 14 per cent per annum compound, and at this rate should double every five or six years. In fact, traffic congestion is expected to represent 2 per cent of the national income in about eight years or less.

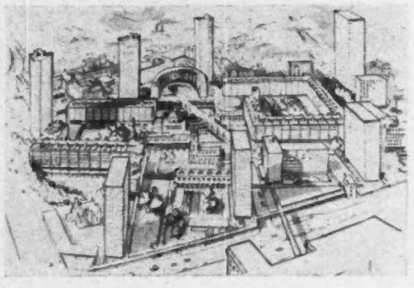
Thus it seems reasonable to state that traffic in London could double within 15 years and that if nothing was done to relieve the congestion then the cost would be in the region of £100 million per year. (In London, traffic now moves at an average speed of about 10 m.p.h. during working hours, a figure that falls to 8 m.p.h. during the evening peak hour.)

To meet this serious situation, two extreme solutions are put forward. Get rid of the private car in London, or get rid of London. Between these two extremes come a number of compromises based on either letting the private car have as much freedom as possible or keeping London as much like it is as possible.

Why London should be kept as it is is incomprehensible to some people who fail to see why the 1960 version of its ugly sprawl is worth preserving. But the need for such a policy is widely held and has recently been put forcefully in a paper "Some Traffic Problems of London," by Mr. A. Samuels, chairman of the London and Home Counties Traffic Advisory Committee, read before the Royal Society of Arts. Taking up the point that some experts have advocated the large-scale construction of new roads in London to keep pace with the advancing vehicle numbers, the author argues that in the present circumstances this would simply attract more and more vehicles. "Unless we can first restore order and discipline in the use of the road system as a whole, then in my view a policy of unlimited urban road development would be as useless as building castles in the sand. Admittedly we need more roads, but we need first a disciplined use of those that we have."

Disciplining involves strict control of street parking in order that streets may be cleaned up to assist traffic flow. Once the flow has been restored, attention can be given to ways and means of regulating the use of streets to give them the best and smoothest system of traffic flow through the various areas. Already parking meter areas have yielded increased rates of flow. The average speed in parking meter zones has increased by about 9 per cent, or about 1 m.p.h.

"I personally think that much more can be done through the introduction of one-way systems, and by adequate linkage and control of traffic lights," says Mr. Samuels. "We have carried out one very successful 'Tidal Flow' experiment, at Chelsea Bridge, to increase the flow of traffic at peak hours by giving the main flow more than half the road. I am sure we can find other places where this system would work equally well."



In the Barbican redevelopment scheme pedestrian life is moved up to the first floor, and cars move and park underneath.

"It is one of the premises on which this paper is based that complete and radical reconstruction of London is not practical. It might be possible to argue that the means of transport for the future is the private car, that restrictions cannot succeed in the long run, and that London must be therefore rebuilt to cater for the car. Apart from the enormous cost, and the length of time the work would take, there are social arguments against such a radical solution. London is not one community but a collection of communities, each with its own life. To disrupt these would clearly be unsatisfactory."

However, Mr. Samuels does advocate some reconstruction. He thinks we ought to have another look at the original "A" Ring Road project which was dropped in 1950. "We must not sacrifice London to the motor car," he explains, "but in my view, we shall only cope in the future if we have a limited number of main roads reaching more or less into the centre (perhaps about a dozen in all) each of them up to motorway standard and with limited access and connected to each other by a small radius Ring Road. Traffic desiring to go through London would use these roads and would never have to use the ordinary all-purpose roads at all. Traffic wishing to stop in central London would be able to come close to the centre by these motor roads, and would only have to do the last mile or two by an ordinary all-purpose road."

Other suggestions put forward by the author are the use of Bailey Bridge construction to build fly-overs cheaply and quickly, encouragement of public transport (including the building of the proposed Victoria underground line), staggering of working hours, diversion of buses from main routes to side streets cleared by parking regulations, planning restrictions on building (to keep offices, for example, near the main rail termini), and stabilisation of employment figures in central London. He considers that what is needed is a plan, based on the use of public transport by the great majority and worked out on a realistic estimate of what the existing radial pattern of public transport is designed to achieve.

Mr. Day opposes this view. He considers the attitude that the car is the wrecker of cities and should be prevented from spreading as profoundly undemocratic and hopelessly unrealistic. "Whatever we do," he argues, "the car population is going to rise inexorably. If we do not plan our cities for the car they will become more and more intolerable places to live in. By isolating the car on special motorways, just as we isolate trains on railways, we make it possible for life to become tolerable again for the pedestrian, for whole precincts to be cut off completely from through traffic. The present sort of compromise of widening and improving existing urban roads makes life hell for everyone—driver and pedestrian—and is quite inadequate to deal with future traffic flows."

Fundamentally, Mr. Day feels that cities are unhealthy, unwanted, and out of date. He would like to see the development of a network of villages of 5,000 or so population, close knit and as little as 600-700 yards across, spaced about 3 miles apart, and linked by a motorway system.

LONDON WITH MOTORWAYS

Harking back to the city, a common feature of both Mr. Samuels' and Mr. Day's proposals are the introduction of urban motorways. Note that two people with opposing views on the future of traffic in London should agree on the need for motorways. Clearly, they both see motorways as the only way of dealing with traffic congestion but disagree on their effect on the character of London.

Leaving the traffic potentialities of urban motorways for later consideration, we can look a little closer at the implications of the system suggested by Mr. Samuels. The ring motorway would have to be a multiple lane affair capable of handling smoothly the traffic of 12 motorways. It would require 12 complex intersections as well as a number of access ramps to provide links with the central area. The ring motorway would probably have to be at least twice as wide as any existing road in London, and the 12 motorways feeding it would probably be up to 50 per cent wider than existing through routes. Each of the twelve intersections would spread over a large area, certainly larger than the Hyde Park Corner or Marble Arch schemes. It is very difficult to

see how the present character of London could be maintained under the impact of such an enormous engineering project.

In a paper "Transport: The Crux of City Planning," by Mr. C. D. Buchanan, Urban Road Planning Adviser, Ministry of Transport, a similar proposal for Fort Worth, Texas, is described. "An effort was made to leave the existing centre more or less intact, but to check the dominance of the motor vehicle. The downtown area was to be ringed by an expressway linked to the main radial expressways. Spurs would lead off the ring to a number of multi-storey car parks pushed well towards the centre so that most parts of the central area would be within easy walking distance . . . Well, that sounds fairly simple and straightforward, but the implications when you look into them are terrific. The circular expressway is not a modest little ring road of the kind we have become accustomed to in the post-war plans. It is a gigantic full-blooded American motorway, many lanes wide, with highly elaborate multi-level intersections. The parking garages are huge mechanised structures, so large that moving footways are necessary.

"The interest of this scheme is that it purports to give the answer to the motor vehicle without wholesale demolition and redevelopment of the place. It might therefore be termed the not-too-drastic solution, but there is no doubt that the measures are in reality very drastic indeed."

LONDON WITHOUT MOTORWAYS

It is inevitable that if such a motorway system were brought into London then the character of the city would change very much. But without motorways, the present system of roads is likely to be improvable only to the extent of providing for a flow of 50 per cent more traffic, a figure quite low compared with the rate of increase of car ownership. Thus if London were required to retain its present character, it would have to do so by relying on severe parking restrictions and the vigorous development of public transport.

But this policy may merely be an alternative way of killing London. In a paper "Saving the City from the Stranglehold of Traffic." Mr. C. T. Brunner, vice-chairman of the British Road Federation, points out that shutting an area to the motorist means shutting out business. Trends, well-defined in some cities in North America, are becoming apparent in Britain. Thus in Leeds, inadequate parking space has resulted in some office sites remaining empty in central areas, which had previously been regarded as the ideal office location, and in the stiffening of rental values in the outer fringes, as more businesses seek office accommodation there. The same trend is present, if less pronounced, in London, partially because the prestige and other advantages of a site in the central area tend to offset all other considerations. But the situation may well change when the comprehensive control of kerbside parking is effective.

In the same way, if there are severe traffic congestion and parking difficulties in a town centre, shoppers will seek to transfer their custom elsewhere, with the resultant decay of the old centre. In Britain no out-of-town shopping centres have been built comparable with those common in North America, and the shopper, in most cases, can exercise little choice in the matter. Where suitable alternatives do exist, however, some shoppers have left the old established centres. Thus a steadily increasing number of people are travelling into the new towns to do their shopping from some London suburbs and from the surrounding towns and villages.

In fact, probably the only thing that keeps central London alive is that every centre near it suffers from traffic congestion to an equal or worse extent. If Kingston, for example, was readily accessible to the motor car, it could funnel off a great deal of the business and shopping expenditure that goes straight from the suburbs in Surrey to the centre of London by public transport, because of the difficulty of driving and parking in Kingston.

The Royal Commission on Local Government in Greater London has recently stated that a city without its road traffic might be a pleasant quiet place but it would be the quiet of stagnation and death. They go on to say that one must approach London's traffic problems on the footing that more and more motor vehicles will yearly appear on London's streets and roads, and that provision must be made for their mobility. Does this automatically mean a system of urban motorways?

WHY MOTORWAYS ANYWAY?

Opinions on the value of urban motorways differ. Here is the view of Mr. J. D. C. Churchill, Assistant Secretary, London Transport. "It is commonly assumed," he says, "that despite the manifest failure of this policy in the USA, the solution of urban traffic congestion is the

Traffic varies with the time—and with the season. The Christmas peak is a foretaste of the future.

construction of urban motorways. An urban motorway gives the private car its own right of way which makes it superior in speed to the fastest public transport, and it will lead to the permanent congestion of central city streets."

Mr. Churchill's remedy is to improve city streets by removing conflicting traffic flows, creating adequate general purpose ring roads, and above all preserving streets for movement. The car commuter would be discouraged from entering the city by parking regulations.

On the other hand, Dr. W. Fisher Cassie, Professor of Civil Engineering at Durham University, has stated after a visit to the United States, "We found the urban motorways of USA (although a small mileage in relation to the total street system) effective in relieving congestion in cities, but depending for their effect on the city street and parking programmes. Municipal engineers are concerned with keeping the traffic moving, but have recently supplemented kerbside parking by entering the field of off-street parking both on parking lots and underground garages. The provision of day-long and reserved parking is still left to private enterprise . . . The result of all these attacks is that highway traffic in cities, although often three times the volume of 20 years ago, may find as much as 60 per cent greater mobility."

The need to study the actual journeys made by vehicles before deciding on new through motorways is stressed by Mr. Buchanan. He considers that a new social habit has arisen. The motor vehicle has become part of the ordinary equipment of daily life and its great value is its penetrative abilities. "I think that the present pattern of movement in urban centres would be revealed not only as a series of canalisable journeys but also as a maze of criss-cross journeys amenable neither to canalisation nor to direction into a few terminal stations," he states. "If I am right about the penetrative power that people wish to exploit above everything else, then I think it is at least clear that the solution of urban traffic problems does not lie simply in constructing or improving a few main arteries for canalised traffic flows. It is a much more complicated matter involving roads and buildings together in the interstitial areas between the canalised flows. It is in these areas that the motor vehicle comes to roost in more senses than one. I think that buildings and access ways need to be considered together as part of a single design problem, in much the same way that an architect designing some large building such as a hospital with many complex problems of circulation, works the whole scheme up with constant attention to the intimate relationship between accommodation and circulation."

Mr. Buchanan also emphasised the architectural and planning problems involved in bringing the motorways into urban areas. Many people go abroad and come back quite dazzled with the engineering works they have seen and do not admit that there is a problem. Others, however, are appalled at the destructiveness of the new roads, the way they sever districts, the blight they cast on adjoining lands, the enormous areas of land they require, particularly in their labyrinthine intersections.

An architect's view of the place of roads in cities has been put by Mr. Frederick Gibberd. "The old all-purpose road—building frontage, vehicles, pedestrians—is now defunct. We need an organic system of design in which traffic is piped or canalised between zones of building use. On main town roads traffic flow has priority over other functions. Within towns, building zones or precincts, roads are secondary in importance to pavements and buildings," he has stated. "The modern road and its junctions are exceptionally wide elements and tend to open up or break asunder the town's spatial pattern with disastrous results . . . today a traffic intersection is functionally unsuitable for building frontage."

If the traffic capacity in London is to be increased in proportion to the greater amount of traffic on Britain's roads then private construction of office blocks and public construction of roads can no longer be allowed to go their separate ways. The relationship between accommodation and circulation has to be taken seriously into account. A suggestion as to how this might be done is provided by Mr. Gibberd, who states emphatically "All problems of road engineering within the urban environment are inseparable from architecture and their solutions requires the collaboration of the architect."

Perhaps a pointer for the future is provided by the Barbican redevelopment scheme, where pedestrian life—with pavements, gardens, fountains—is segregated completely from traffic, which runs and parks underneath it. The "city on stilts" in which ground level is completely given over to traffic and pedestrian life exists one floor up is possibly the most extreme solution to city traffic congestion, and yet the only realistic one if cities as we know them are to be retained. The alternative is "village" groups—high buildings clustered around motorways.

Finally, if these alternatives for the future of London are startling, remember the other solution. The possibility is well summed up by Mr. Buchanan. "Most of us live most of our lives in urban areas, but we seem to be forgetting what towns ought to be like. We are thrilled to bits when someone comes forward with an idea for speeding up traffic by 1·75 m.p.h., or for guard rails to prevent us stepping off the kerb, or for an all-red at the traffic lights to give us another 3 sec to scuttle across more or less in safety. I am not decrying such measures, but I think they are lowly ambitions and that we should have in our minds the vision of urban areas where we don't have to run for our lives at the approach of a motor vehicle, where we don't have to wait mud-bespattered in driving rain for the buses, where we don't have to breathe in vehicle fumes, where we don't have to converse in signs because of the noise, where we don't have to struggle along narrow congested pavements, where we don't have vehicles stationary or moving cluttering up every yard of available space, and where we can wander freely about and take stock of our surroundings and receive the stimulus that a coherent urban environment can give. The prospect that terrifies me is that we shall dodge along from one "improvement" to the next, widening out and opening up, destroying things of value right and left, but even so never catching up with the motor vehicle. I think that is the sad lesson of the last 40 years."

Towards Less Protection for Industry

Deliberations of GATT are always of vital concern to British industry, but its current meeting is made more crucial by the group interests of the European Economic Community and of the Free Trade Association.

By Richard Bailey

SINCE the beginning of September the representatives of nearly fifty nations have been meeting in Geneva. They will be there for several months, for this is the fifth trade negotiating conference of the General Agreement on Tariffs and Trade (GATT). What are these experts doing and how important are their efforts to British industry?

The conference will be in two parts. The first lasting until after Christmas will be concerned with the level of the common external tariff of the six-nation European Economic Community. The second part, which will follow in the New Year will be an all-round examination of existing tariffs with the object of negotiating cuts and concessions. Both parts of the GATT Conference are important for us, and what is likely to happen in the next few months at Geneva will go a long way to deciding whether Britain is to remain a high tariff country.

The sections of British industry sheltering behind the highest tariff wall today are shown in the diagram. The concentration of manufactured goods including cars, commercial vehicles, radio and television in the 20 per cent or over groups is very striking. Compared with our leading competitors these tariffs are high. The British tariff on cars, for example, is 30 per cent. The common tariff of the Common Market will be 27-29 per cent, that of the USA being 8½ per cent. Further, because of the way in which purchase tax is calculated on the landed price plus tariff, the effective rate of protection is about 45 per cent. One item on which Britain shows up well is machine tools where the Common Market tariff is from 5 to 13 per cent, the American 15 per cent and the British 10 per cent.

But apart from being high level the British tariff system can be criticised from another angle—it is out of date. It was largely created in the 1920's and early 1930's to meet the conditions of those difficult times. Today the whole set up looks as out of date as a Model T Ford. The duties on cars, watches, clocks and musical instruments were first brought in as part of the McKenna duties of 1915 to help pay for the First World War. Scientific instruments, organic chemicals, wireless valves and optical glass, another group of high duty products, date from 1921. These were levies imposed on so-called "key" industries regarded as of strategic importance. At that time Britain was still a free-trade country.

Some British Tariff Barriers

Highest level 30-33⅓ per cent	High level 20-25 per cent	Medium 15-17 per cent
Tyres,	Films,	Agricultural Machinery,
Commercial Vehicles,	Toys,	Boilers,
Valves,	Motor cycles,	Pumps
Organic Chemicals,	Radio and Television sets	
Clocks and Watches,	Switchgear,	
Cars	Cables	

The big change-over to protection came as a result of the financial crisis of 1931, in the Import Duties Act of 1932. The system of Commonwealth Preference was introduced giving free entry or preferential treatment to Commonwealth foodstuffs and raw materials entering Britain, and preference to British manufactured goods going the other way. Since then the value of Commonwealth Preference has fallen steadily. A recent PEP study, "Commonwealth Preference in the United Kingdom," showed that its average incidence was now of the order of 4 to 5 per cent compared with 6 to 7 per cent in 1940 and 10 to 12 per cent in 1937.

The setting up of GATT in 1947 provided a mechanism for eventually bringing order out of the chaos of the world tariff tangle. The present conference has been convened at a time when the contracting parties have a number of problems which they hope can be settled in the context of GATT. The most important of these arise from the setting up of the European Economic Community. In Britain attention has been focused on the relations between the Six and Seven. But the rest of the world are very interested parties—in particular the United States as an exporter of manufactured goods, and the Commonwealth and Latin American countries as suppliers of foodstuffs and raw materials.

The discussion in the first part of the GATT Conference will be under Article XXIV which obliges the parties of a customs union to ensure that they do not set up barriers to trade which are higher than those of its member countries in the past. This will involve the examination of a great weight of paper and the endless scrutiny of tariff schedules.

ADJUSTING TARIFF LEVELS

In the second half of the conference the representatives will get down to the serious business of adjusting tariff levels. The European Economic Community has already stated that it will reduce the external tariff by 20 per cent as part of the process of speeding up its introduction. But the EEC will expect cuts from other nations in return. Where are these likely to come from?

The United States is anxious to remove discrimination against its exports by the Six. The Americans have been moving towards a more liberal tariff policy under the Reciprocal Trade Agreement Act which gives the President power to negotiate tariff concessions of 20 per cent on a basis of reciprocity over a period of four years. The common agricultural policy of the EEC, which insulates the six Common Market countries, by a mixture of tariffs and import levies from movements in world prices for foodstuffs and raw materials, is one of the major problems to be considered. The United States is concerned about this shut-down not only as an exporter itself but because of the effects on the economies of the Latin American and Asian countries. The best way to help the developing countries is to buy their crops.

All countries defend controls to protect domestic agriculture as necessary for balance of payments reasons. These arguments are no longer valid and the time has come when governments everywhere and not least in Britain should look very carefully at the economics of protecting the farmers.

The Six, then, are facing a very searching examination of their tariff proposals over the next six months. What happens to the Seven? Is the European Free Trade Association, the EFTA, also under review? As a free trade area the EFTA is permitted under GATT rules. Not having a common external tariff there is no lengthy period of scrutiny and haggling to be gone through as no change takes place in the treatment of imports from third countries. The main question for discussion is whether the virtual exclusion of agriculture from the EFTA agreement creates new discrimination.

The biggest limiting factor in bringing about a general tariff reduction is the most favoured nation rule. This means that reductions by the Six which are passed on to the Seven would have to be made applicable to the United States and other GATT members as well. The British representative has stated that Britain is prepared to be generous in the matter of tariff reduction. Generosity is likely to be tempered however by the knowledge that the prospects of getting something in return from the Americans are limited. Another problem is the future position of Japan, at present an associate member of GATT but not entitled to most favoured nation treatment.

Who is in GATT?

37 Full Members—

Australia	Finland	New Zealand
Austria	France	Nicaragua
Belgium	German Federal Republic	Norway
Brazil	Ghana	Pakistan
Burma	Greece	Peru
Canada	Haiti	Fed. of Rhodesia and Nyasaland
Ceylon	India	Sweden
Chile	Indonesia	Turkey
Cuba	Italy	Union of S. Africa
Czechoslovakia	Luxembourg	United Kingdom
Denmark	Malaya	United States of America
Dominican Republic	Netherlands	Uruguay

Countries participating under special arrangements include—Japan, Switzerland, Cambodia, Israel, Tunisia, Yugoslavia, Spain, Portugal.

Does all this mean that British firms will be facing a flood of cheap imports as a result of the proposed tariff cuts? The short answer is undoubtedly "No." Britain, as the only major industrial power in the EFTA, is not facing such keen competition as its smaller partners, nor indeed as the Six Common Market countries are introducing. A general cut even as high as 20 per cent would still leave many UK tariffs uncomfortably high for foreign competitors. And if the tariffs of the Six especially those of Germany come down the prospects of increased trade with the Common Market will become brighter. The biggest gains would probably be in those sections of industry whose exports are already expanding—non-electric machinery, scientific instruments, electric machinery, apparatus and appliances, and road vehicles and aircraft. Some goods in all of these categories would undoubtedly gain from lower tariffs in Europe and the rest of the GATT countries.

At the receiving end British industry, because of its higher level of protection, would feel increased competition keenly. Is this a prospect that can be faced with equanimity? The answer depends entirely on whether British management and the trade unions can cooperate in stepping up productivity. There is still a large potential of productive capacity which is not fully exploited.

The results of the GATT Conference will not be known for some months. There is time for managements to adjust themselves to the idea that our tariff protection within EFTA is going to be gradually reduced to nothing, and that there is a possibility of general cuts all round.

A great many man-hours will be spent poring over the schedules in Geneva before the details of any reduced protection for British industry can be known. In the world of today the idea that Britain can get by so long as she protects her slow-growing industries is a fallacy. A really liberal British tariff system is likely to prove the best guarantee of increasing export trade in the long run. In any case this Conference is not going to strip our defences and let in vast quantities of cheap goods. Rather it is a first step towards a new world tariff structure. It should go a long way towards putting the Six and Seven into a world context so that their problems can be seen in the right perspective. When this is done it should be possible to go forward to a lasting solution of the trading problems that have hindered our progress since the war.

Human Element

Engineering Unions Seek Further Talks

FACED with the rejection of their pay claim by the shipbuilding employers and an offer of up to 7*s* a week more from the engineering and allied employers, the executives of 39 engineering and shipbuilding unions have asked the two employers' organisations for fresh meetings at which the wage claims can be further pressed.

The most significant dissentient at the York meeting of the union representatives and the executive of the Confederation of Shipbuilding and Engineering Unions was the Boilermakers Society. They were in favour of asking the Minister of Labour to appoint an official inquiry to discover whether or not it is true, as the employers have explained, that a wage increase in shipbuilding now would further damage the industry's ability to meet foreign competition.

Despite the authority of the boilermakers in shipbuilding union matters this proposal was defeated by the decisive figure of more than a million votes—1,300,000 against, 100,000 for.

Mr. Frank Foulkes, the Electrical Trades Union president, was also defeated, by about a million votes to 300,000, when he proposed that instead of seeking further meetings the unions should simply write to the employers asking for better offers and that the unions should decide what to do in the event of what they considered to be unsatisfactory answers.

If this course of action had been approved it is fair to construe the position that would have followed as one step nearer strike action than will be the position if, after the next meeting, the union representatives still feel the employers' answer to be not up to their expectations. That Mr. Foulkes proposed course was not taken is some evidence of the climate of opinion, at any rate among the union representatives.

More Short-Time in Furniture Trade

Alongside the car firms and the companies producing electrical domestic appliances, the furniture trade has been as badly hit as any by the slowing down in consumer demand.

Harris Lebus, one of the largest manufacturers in the furniture industry, has now put 1,600 of its 2,000 workers on a four-day week. The short time working has been resorted to in the Tottenham, North London, factory of the company. This factory does all the Harris Lebus cabinet work. Upholstery is carried out at the firm's Reading, Berkshire, factory where the 500 employees are still on full time.

A reduced working week is now common in the furniture trade, which employs some 80,000 people. Their employing firms vary in size from a single workroom with a handful of people up to the giants like Harris Lebus and E. Gomme, of High Wycombe, Buckinghamshire. Gomme put 1,000 of their 2,500 people on a four-day week only a few days before the Lebus firm did the same thing.

A substantial decline in output this winter has replaced the traditional build up to a pre-Christmas peak. Unions and employers, acting together through their Regional Boards for Industry, have pointed out to the Government that the prospects for an improvement in the next few months are in no way bright.

Government Engineers Claim New Pay Scale

Engineers, architects and surveyors employed in the Civil Service would be raised to a new pay scale running from £930 to £2,450 a year if a new claim sent to the Civil Service Arbitration Tribunal were to be granted in full. The claim was sent to arbitration after the Institution of Civil Professional Servants had rejected the Treasury's offer to make the pay scale £885 to £2,170.

A reduction of two hours a week for the technical grades gives them a 42 hour working week.

One Big Pay Review Every Three Years?

Does the recent £20 million pay increase for 600,000 civil servants, giving each employee a 4 per cent rise from 1 January, provide a clue towards the solution of the renewed wage rise/price rise spiral?

The National Whitley Council has now agreed a new system for civil servants in which the system of "fair comparison," with outside industry and commerce is maintained but in which undue delay and lengthy retrospection of settlements is avoided.

The new agreement allows for the review of the various classes of the Civil Service by the pay research unit every five years. Since this would make alterations due to the pay research unit's inquiries comparatively infrequent, the new agreement also provides for interim reviews up to the level of Principals.

The fair comparison idea has made rapid strides in recent industrial history. It has been applied to the railwaymen, and the busmen would like it as well. In covering a key section of the working population, such as the civil servants, fair comparison not only gives itself a solid example, but strongly influences wage settlements throughout industry. And this although the civil service is not up against fierce international competition or endeavouring to replace plant and equipment at a furious rate on an inadequate investment allowance.

If an interval of years is thought wise for alterations on the basis of fair comparison, might it not be infinitely wiser to bring in an interval of years between outright wage claims? The annual call of the unions upon the employers and the eventual grant of 3 or 4 per cent more on wages has at least three effects, none of them good. The annual increase means a worsening of price competitiveness in the United Kingdom's products, it means an increase in the costs the worker has to meet just when he thought he was catching up with the last one, and long term forecasting of prices goes out of the window.

The advantages of slowing down the frequency of wage increases are obvious. And not lacking in application. In the United States the wage and conditions of work agreement running upwards of two years is a commonplace of the major industries.

There is not much doubt that responsible British trade union figures believe the stern penalties, under whose threats some unions in Western Europe have to operate, to be the opposite of reasonable industrial democracy. But such rules and regulations are made possible only by public opinion, and a system whereby the settlement of one claim falls only a matter of weeks before the next is taking shape in the union branches is one which has every chance of falling foul of the general opinion.

In terms of practical union management, holding the militants in check in the transitional period from annual claims to, say, a claim every third year, would be extremely difficult. But nothing like as difficult as maintaining full employment in a country without rising productivity but with rising prices.

More Engineering Students in Canada

A 3 per cent increase in the number of undergraduates enrolled for engineering courses in the current university year in Canada is reported by the Engineering Institute of Canada.

The engineering enrolment for the Canadian universities this year is 14,940, an increase of 465 over last year.

Engineering freshmen have increased to 4,461 from last year's 4,122. The Institute has some interesting figures involving the estimated numbers of students expected to graduate next year.

Graduates in the engineering classes next year are expected to be 2,651, an increase of 410 over this year's number.

The largest numbers still go for civil engineering—779 of 1961's graduates are expected to be in the civil engineering section, against 644 this year. The number of electrical graduates is expected to increase from 513 to 644 and the mechanical graduates from 438 to 508.

Of the 32 Canadian universities and colleges offering engineering courses, 21 are degree-granting institutions.

Private Trade Delegation Touring Russian Works

Twelve senior executives from engineering companies are in the Soviet Union as members of the first privately organised trade and technical delegation to visit Russia since the war.

Mixing lectures with works visits, the members of the delegation will put over detailed information on the plant and equipment produced by their own companies and study the progress in related industries, touring factories in Moscow, Leningrad, Kiev and industrial centres in the Urals.

Among the visiting engineers is Dr. A. D. Merriman who led a British military mission to Moscow during the war. Dr. Merriman is lecturing on the tour in his capacity as scientific adviser to the Edgar Allen company, of Sheffield.

The companies contributing executives to the party are:

Richardsons Westgarth, producers of industrial power station installations, marine machinery, turbo-alternators, etc.;

Westool, who make electronic control gear, electric brakes and clutches and coilwinding machines;

Barry-Wehmiller, whose products include bottling and food processing machinery;

John Thompson, refrigeration and mechanical handling;

Turner Machinery, who make complete tanneries and machinery for the leather, rubber and plastics trades;

Edgar Allen, industrial drying equipment, special steels and crushing, pulverising and separating machinery; and

Marshall Richards Machine, wire and tube drawing machinery and precision rolling mills.

AEI Hotpoint on Four-Day Week

Although for some manufacturers the demand for electric cookers remains substantial there is no relief in the generally gloomy picture of sharply reduced demand for electrical appliances. The latest company to introduce short-time working is Associated Electrical Industries—Hotpoint. AEI's domestic appliance company will be putting 650 of its workers, a quarter of the labour force of its main manufacturing centre at Peterborough, on a four day week in the New Year. This works is largely concerned with producing refrigerators.

Full time production continues at the Hotpoint factories at Llandudno (washing machines) and Birmingham (small appliances).

Trade Expansion Moves in South Africa

Three special trade missions are to go overseas from South Africa next year charged with seeking to promote exports. The gold and foreign exchange reserves of South Africa have now fallen to £86 million, from £153 million, last March, an indication of the thread by which the economy of the country now hangs.

The Government is to adopt a number of special measures to try to overcome the outflow of capital due to alarm at the course on which the apartheid policy is leading the country. These include moves to expand the home market, increasing the productive capacity of the publicly owned concerns, export promotion and general tax and budgetary changes.

Apart from the outflow of capital, South Africa's basic trading position is that in the first ten months of the year the current account showed a favourable balance.

Lightweight Concrete Paper Wins Association Medal

The medal of the Reinforced Concrete Association, given each year for the best paper presented to the association, has been awarded to Mr. A. Short for his paper on "The Use of Lightweight Concrete for Reinforced Concrete Construction."

The award, which is accompanied by ten guineas, was made by the RCA president, Mr. W. Kirby Laing, chairman of John Laing and Son. Limited.

Heightening Gravity Dams

Reservoir capacity can be increased by heightening the dam. Mass concrete additions can be difficult. The Coyne method, now being used in the United Kingdom for the first time, offers many advantages.

UNTIL recent years gravity dams could be raised only by adding concrete or masonry to the downstream face to form a larger structure of similar form to the original. A particular problem with this type of raising is that, unless it is possible to empty the reservoir while the new concrete is bonded to the old, it results in an undesirable distribution of stresses across the base—with tension at the upstream edge and severe compression adjacent to the junction. The tension can be avoided if the new concrete and the old are united while the reservoir is drawn down, and most recent developments in this technique have aimed at minimising the period during which the draw-down must be maintained for this purpose. With such methods the handling of flood waters can present difficulties during the period of construction. In any case, most water authorities are loath to lower their reservoirs artificially at any time of the year.

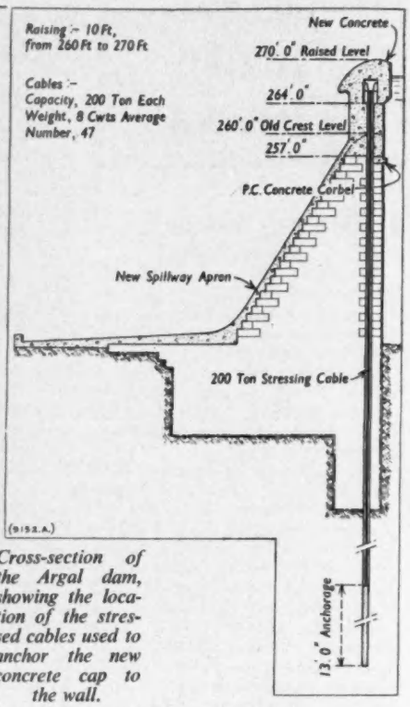
In 1932 the Coyne method of dam raising was first adopted. This method consists of applying a vertical or near-vertical force to the top of the existing dam—by means of pretensioned steel cables—in such a position and of such a magnitude that it will counteract the unbalanced thrusts, uplift and overturning moment, caused by the greater head of water. The method—referred to sometimes as anchor stressing—has the advantages of cheapness, determinacy and speed of construction. In most cases, the work can be carried out without lowering the level of the reservoir.

Made of high tensile steel, the cables are anchored in the bedrock below the dam and tensioned by means of jacks resting on top of it. In most applications the cables have been vertical, installed in holes drilled through the body of the dam itself. In some cases, however, it has proved more economical to incline them—and even to place them in ducts outside the upstream face of the dam.

In examples of such works constructed to date, the cables have varied from 70 tons to 1,400 tons in capacity, and it appears that cables of 3,000 to 4,000 tons could be employed without departing from existing methods of anchoring and stressing. Holes to accommodate the cables have ranged from diameters of 2½ in for 70 ton cables to 14 in for 1,400 ton cables. Under most practical conditions, 3½ in to 4 in diameter holes housing 200 ton capacity cables, give the most economical solution. The cables are anchored into the bedrock by high quality colloidal cement grout with a low water-cement ratio.

The length of the anchorage depends on the quality of the rock and the load. For example, in medium hard basalt an anchorage length of 2 ft in a hole of 2½ in diameter is just sufficient to anchor a 77 ton cable—equivalent to a punching shear of 900 lb per sq. in. In practice, the anchorage length varies from 6 ft for 70 ton cables to 25 ft for the largest cables to allow an ample margin of safety. Stressing heads are of two general forms: either a permanent circular *in situ* concrete head, which is used both for jacking and anchoring the cable, or a temporary steel yoke for jacking—the cable being finally anchored by packing high grade concrete around it—as is the normal practice.

The Argal Dam, near Falmouth, which is being raised by 10 ft using the Coyne technique of anchoring the heightening.


Raising :- 10 Ft, from 260 Ft to 270 Ft
Cables :- Capacity, 200 Ton Each Weight, 8 Cwts Average Number, 47
New Concrete
270' 0" Raised Level
264' 0"
260' 0" Old Crest Level
257' 0"
P.C. Concrete Corbel
New Spillway Apron
200 Ton Stressing Cable
(9152.A.)
13' 0" Anchorage

Cross-section of the Argal dam, showing the location of the stressed cables used to anchor the new concrete cap to the wall.

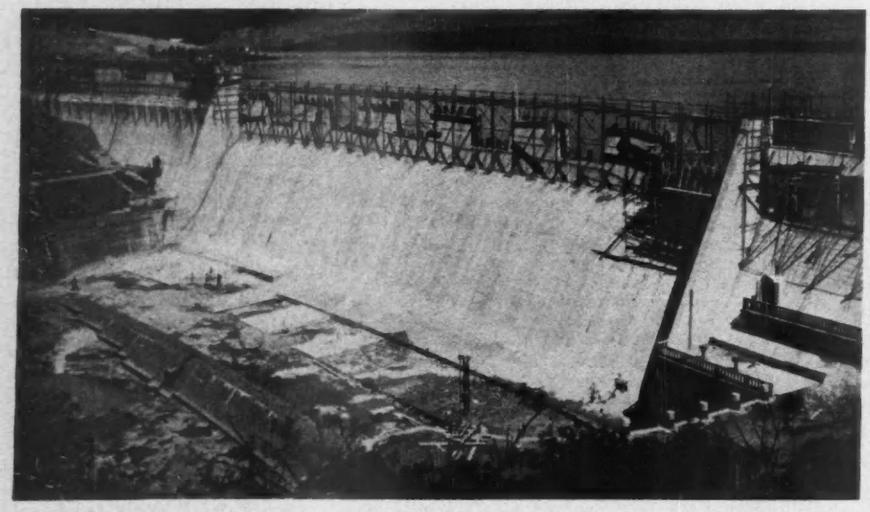
Calculation of the depth of anchorage is of necessity a matter of experience and judgment rather than of rigorous analysis. Generally, the depth is such that the weight of an inverted right cone of rock—reduced as required by cable centres—with its apex at the centre of the anchorage and its base at the bottom of the dam, is equal to the design tension in the cable. There is evidence that this approach is conservative but the saving by applying more advanced theories is negligible.

In his paper on the Allt-na-Lairige prestressed dam, Mr. J. A. Banks gave the saving in cost compared with that of a gravity concrete dam as 15 per cent (*ICE Proceedings*, vol. 6, Mar. '57, p. 409). This figure is typical of the saving on a new dam by adopting a prestressed design. For raising an existing dam, however, the saving can be much greater because of the high cost factor of preparing the downstream face of an existing structure for conventional raising.

While the underlying principles of anchor stressing are simple in conception, successful execution involves a great deal of specialist knowledge and experience to solve the difficult problems involved—drilling truly straight holes of relatively small diameter to great depths; placing accurately measured quantities of anchor grout in the bottoms of the holes; homing the cable into the anchor grout without disturbing or diluting it; and protecting the cable from corrosion by high-pressure grout injections throughout its length.

The Coyne method is being pioneered in the United Kingdom with the heightening of Argal Dam for Falmouth Borough Council. Rofe and Rafferty of London are the consulting engineers to the council and the Cementation Group are the contractors. Cementation have used the Coyne method on more than a dozen major dams overseas, especially in India and South Africa, but this is the first time it has been employed in the United Kingdom.

Apart from the raising of dams, applications for anchor stressing include the strengthening of dry docks, sea walls, dams, caissons, tunnel roofs—in fact, any structure that can be held in position by tying it with a known and constant force to the ground below, behind or above it. A particularly interesting example is the tying down of the main piers of the new Forth road bridge to counter the forces transmitted by cables.



The Henley Dam, Pietermaritzburg, South Africa, which was raised 23 ft by the Coyne technique.

Professor Casagrande to Give Rankine Lecture

The British National Society of Soil Mechanics and Foundation Engineering has announced the founding of an annual Rankine Lecture.

The inaugural lecture will be delivered by Professor Arthur Casagrande, of Harvard University, at the Institution of Civil Engineers in London on 25 January, 1961. The title of his lecture will be "Analysis and Control of Seepage for Dams." Professor Casagrande, born at Haidenschaft, Italy (formerly Austria), in 1902, is recognised internationally as one of the leading figures in soil mechanics and foundation engineering. He is Gordon McKay Professor of Soil Mechanics and Foundation Engineering at Harvard.

Mr. J. K. T. L. Nash, chairman of the British National Committee of the International Society of Soil Mechanics and Foundation Engineering, has said that the Rankine Lecture will be delivered alternately by lecturers from outside the United Kingdom and at home. He added: "The British National Society was formed after the 1948 International Conference at Rotterdam; its membership then consisted of a handful—today it exceeds 350. This growth is a measure of the wide and increasing interest shown in foundation engineering in this country." Mr. Nash also believes that engineers in the United Kingdom "will welcome the opportunity of having Professor Casagrande and other distinguished engineers lecturing in their won field."

The lectures have been found in memory of William John MacQuorn Rankine (1820-1872), civil engineer, who was appointed to the chair of civil engineering and mechanics at Glasgow University in 1855, and occupied it until his death. He was born in Edinburgh and attended the University in that city. He was one of the pioneers of soil mechanics and foundation engineering.

More Rubber Roads for Australia

In the past year, reports *Rubber in Roads*, Bulletin No. 15, published by the Natural Rubber Bureau, "more rubberised surface dressings have been laid in Australia than ever before. . . ." This is significant, the Bureau claims, because nowhere has the rubberised road been given a more thorough testing under difficult conditions of climate and terrain than in Australia.

The bulletin quotes at length from a report by Mr. J. Mathieson, M.C.E., M.I.E.(Aust.), chief engineer of the Victorian Country Roads Board. "Past experience," Mr. Mathieson stated, "appears to have proved that the addition of rubber to bitumen in sprayed seal coats is an advantage when the surface to be treated is badly cracked, the increased elasticity of the bitumen apparently providing more tolerance to movement in the pavement and, following this, five miles of cement stabilised sand pavement . . . have been sealed with bitumen in which was incorporated 2 per cent of rubber powder."

After giving details of the pavement condition and the method of work he added: "It was particularly noticeable that the binder was more 'sticky' than usual, and its adhesion to the stones much better than on the control section which had no rubber in the binder. . . . As the result of this experience, cement stabilised sand pavements constructed during April and June, 1959, totalling approximately five miles, have been sealed with bitumen in which was incorporated 2 per cent of rubber powder."

Mr. C. C. Perrin, A.M.I.E.(Aust.), also of the Victorian Country Roads Board, commented: "There is evidence to suggest that the addition of rubber to the bitumen increases its softening point, its resistance to cracking in low temperatures, its elasticity and ductility which appears to improve its tolerance to expansion and contraction, its resistance to impact, and in certain circumstances its qualities of adhesion. . . ." Mr. Perrin went on to describe work done in cold weather using rounded river gravel as aggregate, a material with which it had been found difficult to obtain an enduring surface on heavily trafficked roads. He added: "The rubberised work is now in very good condition, whereas considerable stripping of the stone has taken place on the adjacent sections on which normal bitumen was used."

Copies of *Rubber in Roads* are available, free of charge, from the Natural Rubber Bureau, Market Buildings, Mark Lane, London, EC3.

Flame Gouging Speeds Bridge Erection

Use of oxy-acetylene flame gouging on the all-welded Thames Bridge being built for the Maidenhead By-Pass near Bray, Berkshire, has speeded up the project and saved money. The bridge is expected to be completed early next year.

More than 1,500 ft of initial welding on the high tensile girders of the bridge has been flame gouged to prepare the roots of the welds for seal welding. Conventional chipping and grinding methods were used at first, but found to be rather slow and threatened to delay the project. Gouging was then used and it has proved to be at least 50 per cent faster and has given a satisfactory finish.

The bridge is 100 ft wide, 348 ft long and has a clear span of 270 ft. It is a composite structure of steel and reinforced concrete with eight steel main girders. The gouging was done with British Oxygen "Saffire" equipment and gases.

The main contractors for the project, which is being carried out for the Ministry of Transport, are Horseley Bridge and Thomas Piggott Limited, with site erection by Carter-Horseley (Engineers) Limited. Freeman, Fox and Partners of London are the consulting engineers.

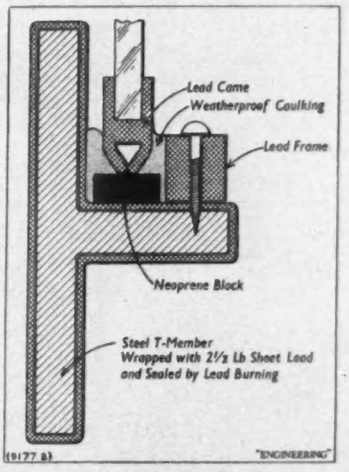
Largest Glass Window Defies Hurricane

When the largest stained glass window in the world—317 ft long by 21½ ft high—withstood gale force winds during Hurricane Donna last September, it proved that a massive area of leaded stained glass could endure destructive winds. More than 7,000 sq. ft of coloured glass—which dominates the facade of the new American Airlines passenger terminal at Idlewild International Airport—resisted gusts measured at over 58 m.p.h.

According to the Idlewild Weather Bureau Observatory, steady peak winds blew at 46 m.h.p. for two hours during the early afternoon of the 12 September. The storm was the worst of the season and 5·83 in of rain fell at the airport during a period of only 12 hours. Throughout the hurricane the window remained airtight.

The giant window's ability to withstand such heavy winds is claimed by the Lead Industries Association of New York to be attributable to the lead frame construction. To exploit to the maximum lead's properties of giving under pressure, and of absorbing vibrations, the fabricators set each pane of glass and each of the 936 panel sections in lead cames (flexible grooved rods). The supporting steel network of frames into which each panel section was fitted was wrapped with 2½ lb sheet lead and the lead seams burned to form a hermetic seal.

(Below) Stained glass window, at Idlewild. (Right) Details of the fixing.



Soil Stabilisation of "Dirty" Railway Track

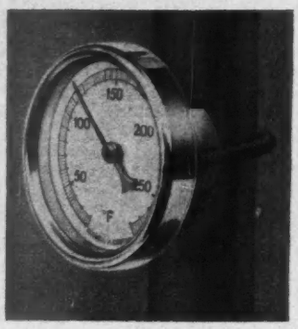
During the recent works in connection with the electrification of the Eastern Region of British Railway's lines between Hertford and Bishop's Stortford, the opportunity was taken to test new methods and types of equipment including excavating machinery and ballast consolidators.

A section of line at Southbury station, which in the past had given trouble due to the silty clay formation being "pumped up" and fouling the ballast, was subjected to soil stabilisation. This was done by mixing a small percentage of cement (between 6 per cent and 10 per cent, depending on the moisture content of the formation) with the top 6 in of the formation. A thin layer of waterproof material, covered with 3 in of small granite chippings, was laid over the formation, followed by slag ballast and the track relaid.

The normal treatment for bad formation of this type is to excavate to the undisturbed level of the formation and lay a blanket of sand. This treatment requires a considerable amount of excavation and the soil stabilisation method was found to be a less expensive procedure.

THERMOMETER

Round or Flat Surfaces



SURFACE thermometers for fitting on round or flat surfaces are now available.

Illustrated is the model for fitting to pipes. It is held in place by a spiral spring, there being a range of four spring sizes to suit pipes of different diameters; size 1 covers from 1 to 1½ in; size 2 from 1½ to 2¾ in; size 3 from 2¾ to 4 in; and size 4, the largest standard type, from 4 in to 7 in. The instrument has standard ranges of 30° to 280° F or from 0° C to 180° C. Other ranges can be supplied to order.

Contact between the instrument and the pipe is by a soft copper plate, oblong in shape, which is easily adaptable to fit snugly on the pipe. A ceramic insulating collar can be fitted if required. Operation is by a bi-metallic strip contained in the body of the thermometer, and acting directly on the pointer. The dial is 2½ in diameter.

The second model is designed for use on flat surfaces. Like the one already described, contact is made through a soft copper plate, but in this case a flat one, 1½ in diameter. Fixing is carried out by using screws directly on the surface or by clamping the instrument in place with brackets. A ceramic insulating collar can be added to this model also. The main purpose of both types is for hot water installations or other hot liquids, and they frequently can take the place of primary instruments. *Regwell Limited, 11 Birchfield Road, Six Ways, Birmingham 19.*

POWER TUG

Petrol Driven

THE illustration shows the Arden power "tug," a general purpose rider controlled machine.

Power is supplied by a 3½ h.p. petrol engine, air cooled and working on the four stroke cycle. Two models are available: either by Clinton or by Briggs and Stratton. The drive to the single wheel is by a centrifugal clutch to a 40 to 1 worm reduction gear totally enclosed and running in an oil bath. The final drive is by a heavy duty roller chain to the wheel. There is only one control for engaging the clutch, accelerating and stopping. Reversing is carried out by turning the wheel through 180°.

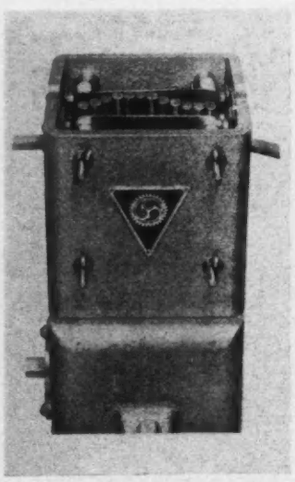
The turntable is set low for maximum stability and consists of two 10 in diameter ball tracks packed with hardened steel balls. The complete assembly is attached to the vehicle platform by two bolts, allowing easy exchange.

On level ground the tug will haul 10 to 12 cwt, and on steep gradients up to 7 cwt depending on the road surface. The weight is approximately 2½ cwt.

The Track Grip driving wheel runs in grease packed bearings which need no attention, and the rear wheels have 10 in by 3 in heavy duty pneumatic tyres and run in roller bearings. Other wheels can be supplied if required. *Arden Plant Limited, Sopers Lane, Poole, Dorset.*

CHEMICAL PUMP

No Contamination



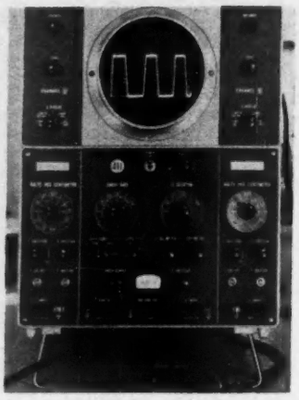
CHEMICALS, either liquid or gas, can be pumped through tubing in the 192 series of pumps.

These operate through a series of fingers, driven from a cam, that move sinusoidally, compressing a length of tubing against a spring loaded plate. The cam is driven directly from the main shaft which can be turned by hand or under power. There are four sizes of pump made in the standard range with capacities from 6 gallons per hour to 120 gallons per hour on tubes from ¼ in to 1 in internal diameter.

The flow rates of each model can be varied in three ways. First by varying the size of tubing used (there are three tubing slots in the body); second by altering the speed of the operating fingers; and third by adjusting the load on the spring plate holding the tubing. In the smaller models the first method gives a flow range of 12 to 1. The pumps will handle liquids up to 2,000 centipoises but with a corresponding reduction in rate. Suspended solids do not interfere with the performance and the use of expensive corrosion resistant materials is avoided. *Apex Construction Limited, 15 Soho Square, London, W1.*

OSCILLOSCOPE

Ultra High Sensitivity



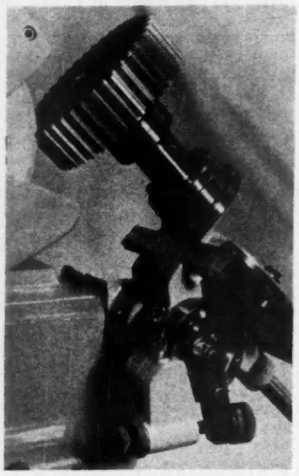
NOW being made available in this country is the Dumont oscilloscope type 411.

This instrument has an ultra high sensitivity on both beams. The dual gun operates on a common time base and each vertical channel can be operated independently of the other. There are amplitude calibration facilities on both. The common time base has a precisely calibrated sweep for quantitative analysis.

X-Y plotting is controlled from the front panel. The signal applied to the vertical axis of one channel may be applied to the horizontal axis of the other, still leaving an unused beam and the sweep generator available. The calibrated sweep range extends from 1 sec per cm to 1 μ sec per cm in 19 steps. Slower sweep speeds are obtainable by connecting external capacitance to the rear terminal board. Uncalibrated sweeps are continuously variable from 1 sec per cm to 2 μ sec per cm. Either driven or recurrent sweep modes may be selected at the front panel. The sweep can be expanded up to five times full scale and any 10 cm length can be positioned on the screen. Synchronising can be by positive or negative signals from the Y amplifier of either channel; by external signal; or by the power line. *Aveley Electric Limited, South Ockendon, Essex.*

DE-BURRING GEARS

Up to 12 in Diameter



THE Burrows and Smith D-Burr is a machine for de-burring gears of any tooth form up to 12 in diameter.

Claims put forward for the machine are that it is inexpensive, can be operated by unskilled labour and will remove the heaviest burrs leaving a precalculated chamfer on the teeth. As the operator has to use both hands to work the machine, a high degree of safety results.

Spur, helical (up to 20° angle) and bevel gears can be machined as well as sprockets and ratchets. An attachment is required for bevel gears, however. Gears are mounted on the freely rotating spindle of the workhead and engage with the grinding wheel which is formed like a worm. Thus both grinding and rotation are carried out.

The workhead has an angular adjustment of 20° either side. Longitudinal adjustment of the head allows the full width of the grinding wheel to be utilised. The wheelhead is adjustable transversely and the drive unit is capable of 12 stops and starts per minute. The motor switch lever is spring loaded so must be held over during the actual grinding. *Alfred Herbert Limited, Coventry.*

AIR FILTER

Ceramic Element

SOLIDS and oil and water droplets are removed from compressed air by a new filter.

The model 101 unit uses a ceramic element enclosed in an all metal casing of aluminium alloy. It is designed for a maximum working pressure of 250 lb per sq. in and has a capacity of 30 cu. ft per minute at 125 lb per sq. in.

A deflector on the inlet port imparts an initial rotary movement to the air before it passes through channels and passageways at the bottom end of a conical baffle. An air cone guards against any carryover. The second stage is the passage through the ceramic element, of which there are two versions, a 30 micron grade for general purposes and a 5 micron one for particularly stringent requirements. The elements are provided with plastic mounts bonded to them. The weight of the complete unit is 1¼ lb and the overall dimensions 8¼ in high by 3¼ in diameter. *Doulton Industrial Porcelains Limited, Wilnecote, Tamworth, Staffordshire.*

PNEUMATIC CONVEYOR

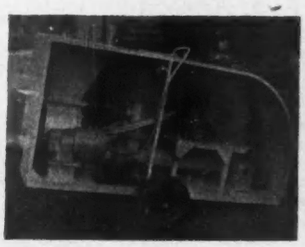
Mobile Unit

Now on the market is a mobile power unit for a pneumatic conveying system.

Advantages claimed are that it can be moved about on site and used to replace semi-permanent bucket and screw conveyors, using flexible tubing or standard steam piping to handle the material. Operation is at moderately high pressure which allows tubing or piping of 4 in bore to be used while yet handling large quantities of material.

The unit is being made in two sizes with either a 20 or a 30 h.p. electric motor to drive the compressor. Alternatively, petrol or diesel engines can be used as the prime mover. The smaller model will produce 360 cu. ft per minute at 5 lb per sq. in and the larger up to 700 cu. ft per minute at 6·6 lb per sq. in. The weights are from 5 to 9 cwt depending on the type and size of power unit being used. Both sizes are designed for towing.

The engine drives a Root's type compressor fitted with an air filter. Other



standard fittings include a silencer, pressure gauge, pressure relief valve, and non-return valve. Material is fed into the system with a rotary valve, designed by the company, driven by a ½ h.p. geared motor. Two 9 ft lengths of 4 in flexible pipe with instantaneous couplings are included.

Depending on the material, the unit will handle up to 20 tons per hour and installations have been handling cubes, pellets, grain, coal, cement powder, and cocoa powder. The unit in the illustration has had the pulleys and driving belts removed for clarity. *F. E. Callow (Engineers) Limited, Kirkby Industrial Estate, Liverpool.*

AUTOMATIC STARTER

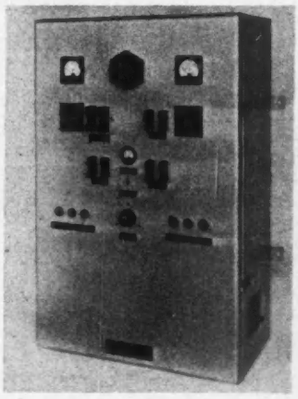
Supply Continuity

The Sicon panel will provide a starting signal to a diesel generator set in the event of complete or partial failure of the mains supply.

The mains supply is automatically isolated from the load and the alternator connection made to the load after the voltage has been built up to the required value and frequency. On restoration of the mains, the load is disconnected from the alternator, reconnected to the mains and the engine stopped.

The sensing device consists of three relays which detect a complete loss of voltage, and a hot wire vacuum switch with a control rheostat to provide low voltage sensing. With an inherent time delay this allows for transient voltage drops. A standard frame size is used for a range of duties from 60 to 220A, the relay arrangements being common throughout the range. The only changes made are in the contactor and circuit breaking ratings.

Provision is made for local control so that the engine may be exercised for



maintenance purposes. Fault indicators and alarms to register engine defects, such as failure to start, excessive engine temperature, or low lubricating oil pressure are fitted as required. A battery trickle charger is usually included. *Southern Instruments Limited, Frimley Road, Camberley, Surrey.*

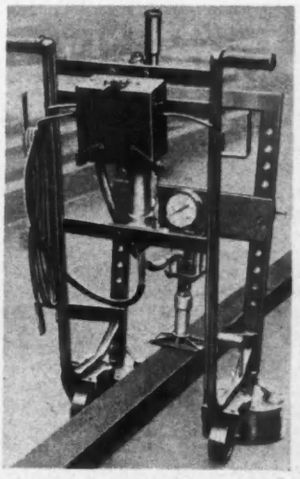
WELDING TROLLEY

Magnetic Clamping

Joists and girders can be accurately positioned for welding and clamped in place by a hand trolley now available.

The trolley has two electromagnets for clamping down and a hydraulic ram for holding the plates or beams in place. A maximum force of 5 tons can be exerted. Stringers and rolled steel joists of all sizes up to a height of 19½ in can be handled. A special feature of the device is that the pressure gauge is calibrated to show the cohesion rating of various thicknesses of plates. It is claimed that the force exerted by the magnets is greater than that of any known type of vacuum clamp.

The trolley is mounted on rubber tyred wheels for easy handling and can be supplied to work from all voltages from 24V upwards. Savings of up to 40 per cent in labour costs of plate clamping have been claimed and the need for temporary welding bridges is removed, thereby eliminating not only the actual welding but also the grinding off of the broken welds after use. The



entire operation can be carried out by only one man. *Melbro Machine Tools Limited, Melbro House, 2A Alexandra Road, Manchester 15.*

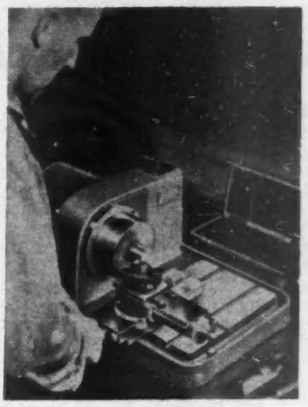
FINISHING LATHE

Auxiliary Work

A finishing lathe for small work is now available in this country.

The Vektor is designed for carrying out auxiliary operations for which a normal lathe would not be an economical proposition. The type of work for which the lathe is suitable is for rapid and accurate cutting off work on tubes and bars up to 36 mm diameter. In the fitting shop it can be used for touching up defective workpieces and for first diameter turning, or shortening bolts and screws. With the addition of a precision three jaw chuck and cross slide, simple parts can be turned and jobs like polishing ground pistons and cylinders can be carried out more economically than on a standard lathe. The main spindle is mounted sufficiently rigidly for circular files to be used.

Power is supplied by a three phase motor rated at 0·25 to 0·33 h.p. with speeds of 700 and 1,400 r.p.m. There are four speeds on the main spindle ranging from 175 to 500 r.p.m. and the spindle is bored to take work up to



36 mm diameter. It runs in double row ball bearings. The three jaw chuck is 135 mm diameter and the cross slide, made by Schaublin, has rapid traverse. All gear wheels are hardened and ground and run in an oil bath. *Roland Goodall Limited, 19 Station Street, Burton-on-Trent, Staffordshire.*

INDEXING MECHANISM

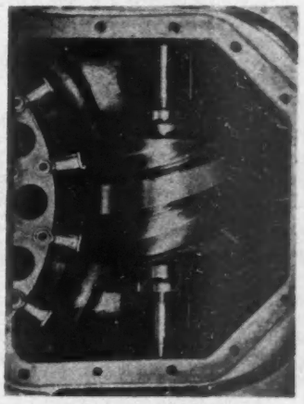
High Accuracy

High accuracy and high speed of operation are two claims for the new Mark II indexing mechanism.

The makers state that the mechanism avoids the acceleration characteristics of the Geneva mechanism and also the overrun of the simple pawl and ratchet but maintains the simple design and low initial cost. A dwell period can be included to suit the operation in hand.

The mechanism consists of a driven turret member carrying a number of radially arranged equally spaced rollers. The driving member is a cam of globoid shape which operates in a similar manner to a worm since it has a "thread" that engages with the turret rollers. Part of the "thread" is straight and the remainder is a helix of varying angle.

When the rollers are on the straight portion the turret is rigidly held for the dwell period and indexing begins when the curved section of the "thread" engages with the turret. The mechanical simplicity of the mechanism allows speeds up to 750 cycles per minute to be



attained. Provision is made for a wide variety of applications with as few as four stops for each revolution of the turret. The firm have prepared a chart listing a range of typical systems. *Manifold Machinery Company Limited, 660 Great Cambridge Road, Enfield, Middlesex.*

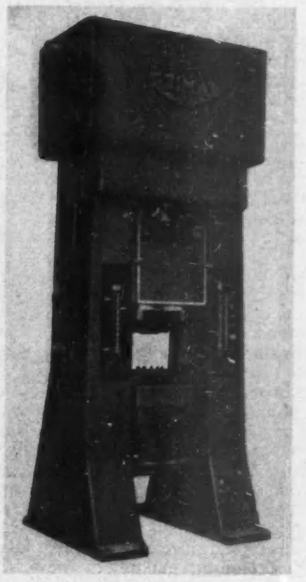
SCREW PRESS

Two-Motor Operation

The Grimar range of screw presses now available in this country are driven by two separate electric motors.

The standard flat disc friction drive has been abandoned and replaced by two cylindrical rollers, each driven by an electric motor through belts and running in an oil bath. Reversing is obtained by clutch and dead braking with electro-pneumatic control either by push button or movable foot switch. The tool holder slide is stopped instantly at any point in the stroke as soon as the switch is released. The system allows for continuous operation; single stroking; and inching.

Both the power of the blow and the length of the stroke can be adjusted, the two being independent. An index scale with vernier is provided at the side. The design concentrates the force of the blow into the initial impact. Eight models make up the range with capacities up to 1,800 kg (approximately 4,000 lb). *Dowding and Doll Limited, 346 Kensington High Street, London, W14.*



More Airline Passengers—and in Comfort

The introduction of Economy and Thrift fares has made it essential for airline operators to get rather more than the recognised pint measure into each pint pot. High density travel has become an economic necessity.

For this reason, Aircraft Furnishing Limited was formed four years ago to design and produce aircraft chairs which, while maintaining the highest possible standards of comfort and safety, would be light enough to increase seating capacity without an increase in weight and would enable seats to be fitted more closely together. These aims, it is said, have been met more successfully with each Lonsdale seat produced by this company.

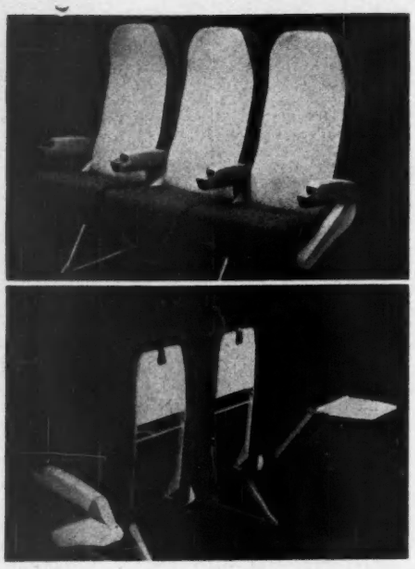
In April, 1958, the BOAC Britannias were equipped with the first Lonsdale seat, the T 34, and the same model was later adopted for BEA's Viscount 701's and Comets. This was the first tip-up seat to be used in an aircraft and this factor, together with specially designed shin clearance, enabled the pitch setting of seats (i.e. the distance between the front of the armrest of each seat and the same part of the seat in front) to be reduced from 39 in to 34 in. The second Lonsdale seat, the 200 series, introduced alloy forgings in legs, side and centre members and has earned £130,000 in export orders during the past two years, its users including Aerolineas Argentinas, CMA Mexico, Misair and Olympic Airways.

Now, the third seat in the series, the Universal Flyweight, carries the design ideas embodied in its predecessors a stage further and provides operators with a tubular style seat 45 per cent cheaper and 27½ per cent lighter than the Lonsdale 200. Fitted with tip-up seats, folding intermediate arms, tables and a choice of fixed or reclining backs, the new chair is designed to allow the pitch setting to be reduced to 28 in while shin clearance is at least 15 in—enough for even a tall man to be quite comfortable. Including upholstery, tables, safety belts and life-jacket stowage, it weighs less than 18 lb per seat—a weight saving of 55 lb for a stack of three—and is available as triple or double seats.

The seats are built around a high tensile steel monospar which is, in effect, a torque tube and allows energy created to be absorbed in the winding action of the tube. This structure satisfies fully the British Airworthiness Requirements and the American Federal Aviation Authority specifications. Indeed, whereas the BCAR demand testing under deceleration of 9*g*, it is stated that the Universal Flyweight is tested under deceleration of 10·4*g*, so that it is not only lighter but probably even safer than earlier seats.

Another important feature of the Universal Flyweight is its versatility. It can be fitted to a wide variety of aircraft—this is more difficult than it might sound because the floors of different aircraft can have very different pick-up points—so that an operator with a mixed fleet can begin to think in terms of seat standardisation. Variations in design and upholstery are also available to meet the requirements of individual airline operators.

Already, the Universal Flyweight has been ordered by BOAC for Britannias on the Skycoach cabotage service.



The Universal Flyweight, front and rear views, showing the new monospar construction which can absorb energy created under deceleration at up to 10·4g.

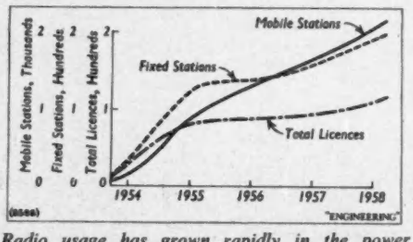
Power Industry Needs More Radio Space

Although it provides the prime energy source for industrial and domestic purposes, the electricity generating industry do not appear to be able to convince the Post Office that radio communication has an important part to play in the production of a reliable supply. It is argued that the number of frequency allocations made by the Post Office, on the basis of a range of 15 miles, is completely inadequate for the requirements of the industry.

Since 1948 the maximum demand on the electricity supply industry has increased from about 10 to about 20 GW. The increase has necessitated a great improvement in communications for both distribution engineering control and consumer service. Normal Post Office and private telephone networks, although originally adequate, have been found not always able to cope economically with the increased traffic. The industry had to turn to radio communication to provide links between fixed points and mobile telephony services. However, the industry has only limited permission to operate a radio circuit unless one or both ends are mobile.

The absence of a reliable radiocommunications network in the industry could have severe consequences. In the event of a national emergency, when the likelihood of extensive damage to the power network and the land-line system would be great, the use of radio for civil defence purposes in the industry would be essential, as are the similar uses by the military and other authorities. Apart from the difficulties caused by the interruption of supplies, danger to life by the equipment can be enhanced if reliable and instant communication is not available. In addition the time involved in the restoration of supplies after breakdown can be considerably reduced by the use of radiotelephony, providing, as it does, a flexible and continuous communication scheme over a wide area. In many instances coal mines and gas works are dependant on electricity supply, and in the oil and other processing industries, catastrophic losses can follow a prolonged failure of power, and serious dangers can arise if explosive conditions develop.

The electricity supply industry originally consisted of a very large number of small undertakings, and thus the problem of allocating frequencies for the use of the industry was not tackled as a single problem from the outset. Frequencies were allocated at various points in a v.h.f. band reserved for commercial users. This band is now very overcrowded and it cannot



Radio usage has grown rapidly in the power industry, outstripping the number of frequencies available.

be extended in either direction, owing to allocations which have already been made. The electrical industry has co-operated with the other fuel and power industries, that is, coal and gas, in the investigation of frequency requirements, and has produced a plan on the basis of 80-mile spacing of fixed stations, sharing frequencies where possible and taking into account the administrative boundaries and the geographical barriers. This has in the main been agreed with the Post Office.

The original plan was based on the allocation of two frequency channels in the 80 Mc/s band and three in the 170 Mc/s band. Experience has shown this to be inadequate too, considerable interference between stations occurring.

The graph shows the rapid rise in the use of radio equipment by the power industry, and no falling off is apparent. It is now considered that the fuel and power industries require at least 26 frequency channels for mobile use, of which the electrical industry requires 14, and these should preferably be situated in a continuous block of the frequency spectrum. Indeed, one might contend that the needs of the fuel and power industries are such as to warrant a special section of the frequency band for their exclusive use.

As far as fixed services are concerned, the supply industry has been endeavouring to establish them on an experimental basis since 1938, but owing to changes in frequency-allocation policy, little progress has been made in this direction until comparatively recently, when a microwave frequency in the 7·3 Gc/s band was made available, subject to certain limitations. There is, however, a considerable requirement for the use of fixed links in the 170 and 450 Mc/s bands for various purposes, such as emergency telephony circuits, substation alarms, remote control telemetering and protective-gear schemes.

In both mobile and fixed radio, the frequency allocation situation in some other countries is far more favourable than in Britain. For example, in the United States the Federal Communications Commission publishes clear rules which lay down the frequencies available for both mobile and fixed services in the "Power Service," of the industrial radio service.

Similar difficulties to those met in Britain have been encountered in a few of the Western European countries, and as a result OEEC have emphasised the urgency of this problem and asked members of the organisation to allow sufficient frequencies to be allocated for the exclusive use of electricity systems. Many in the power industry think there is a good case for a review of the whole question of frequency allocations in the v.h.f. and u.h.f. bands, including an investigation into the actual usage of the bands.

(The comments in this article are drawn largely from a paper "Radio Communication in the Power Industry", given to the Institution of Electrical Engineers by Mr. E. H. Cox of the M.E.B. and Mr. R. E. Martin of the C.E.G.B.)

Dounreay Springboard

With thirteen months past since the Dounreay Fast Reactor first went critical, it is a good time to take stock of the situation and review the trials and tribulations that have beset this experimental prototype since its construction. A symposium arranged by the Institution of Mechanical Engineers under the aegis of the British Nuclear Energy Conference was held in London on 7 December, and the six papers presented admirably fulfilled this purpose.

Embryonic Prototype

Mr. R. V. Moore, deputy manager of the UKAEA Development and Engineering Group, Risley, termed the Dounreay project an "embryo for a prototype fast reactor," and one of the disadvantages of building an experimental reactor of this type was the rapidity with which it became out of date. It can thus be assumed that future generations of fast reactors will differ considerably from their ancestors.

Fuel Elements

The factor that most determines the future of the fast reactor is the fuel. Although metal fuel is being used in the Dounreay experiment it is considered to have a short life, and much research is going into the development of carbide and cermet fuels. The fuel element shown in Fig. 1 is made from 45 per cent enriched uranium alloyed with 0·5 atomic per cent chromium. There are seven fuel segments in each fuel element. The segments are isothermally transformed to give a fine grain size as an anti-wrinkling measure, and also to minimise the effects of alpha-beta thermal cycling. The reactivity inserted does not exceed 0·7 per cent, which is an amount equal to the neutron fraction, and thereby eliminates any risk of the reactor going prompt-critical, even if a fuel element did drop into the core.

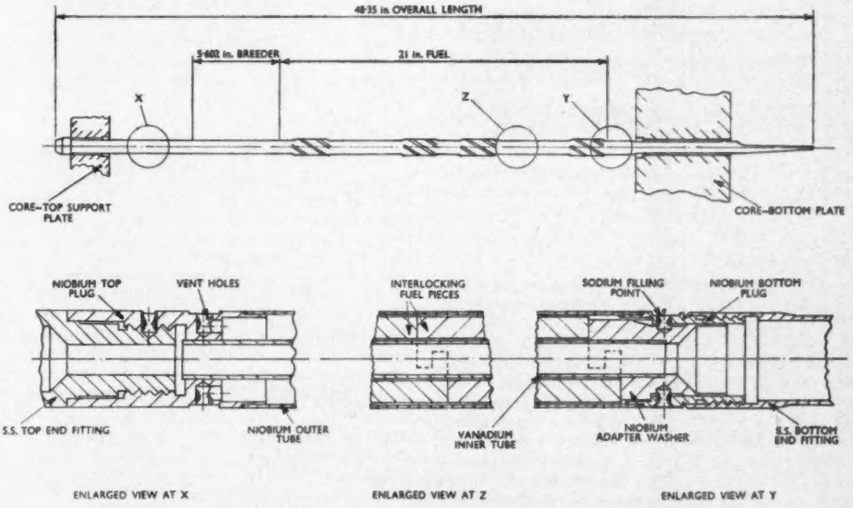


Fig. 1 Details of the core element, showing interlocking fuel pieces.

Canning Material

Canning of fast reactor fuel elements also presents substantial difficulties. The outer tube is made of niobium 0·020 in thick with integral external finning, as shown in Fig. 1, at certain positions along its length. The fins serve to prevent a reduction of the coolant flow past a fuel element should it bow and touch an adjoining element. The inner tube is made of 0·020 in vanadium. This metal was chosen because it has a lower melting point than niobium. In the event of an excessive temperature rise the vanadium will melt first, allowing the molten fuel to run down the inside of the niobium tube to a pool at the bottom of the reactor and thereby preventing the fissile fuel from mixing with the coolant and reflector. Precautions are necessary so that criticality does not occur in the melt. Compatibility studies between niobium and vanadium have given satisfactory results; the variation in the penetration temperature with the rate of heating calculated for the two elements is shown in Fig. 2. Tantalum plated nickel was initially considered in place of vanadium but, in view of the need to guarantee the absolute soundness of the metallic coating, the latter was abandoned.

Sodium Filling

After assembly, the fuel elements are filled with sodium to act as a heat transfer medium between the can and the uranium. It is difficult to ensure that the sodium has filled the gap completely (0·005 in). A void could lead to a hot spot during operation, but it is considered that this fault will be self correcting because, although sodium dislikes wetting, it is nominally more inclined to cooperate at higher temperatures; and secondly, high heat flux tests on uranium canned in niobium have shown the voids deliberately introduced between the uranium and the outer tube are filled by plastic deformation of the uranium, thus reducing the hot spot. But it is hoped that a more satisfactory medium than sodium may be found.

Thermal Bowing

Fuel segments are linked together axially and joined to the bottom of the fuel element to eliminate ratcheting. In order to achieve high ratings with minimum fuel investment the supporting members in the core must be minimised, so that the fuel element pitch may be governed by the heat-transfer performance and not by structural considerations. A small initial displacement of a fuel element could lead to progressive displacement, and as a counter measure the outer can of each fuel element is finned.

Risk of Resonance

An analysis following the melt-down of the American fast reactor experiment EBR1 showed that a combination of the prompt positive and the delayed negative coefficients might lead to a resonance of the reactor and that small movements of the fuel towards the core centre, or regions of higher flux, could give the requisite positive power coefficient. At the same time it became apparent that similar coefficients could arise in the Dounreay core owing to thermal bowing of the fuel elements—the radial temperature gradient across each can inducing the bowing towards the centre of the core.

Core Tube Nest

To guard against this contingency it was decided, after considering many alternatives,

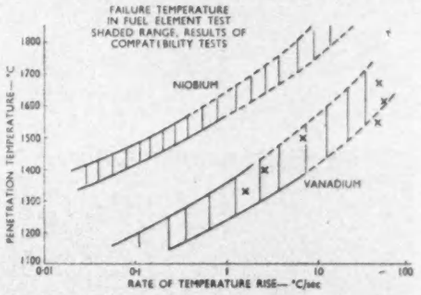


Fig. 2 Can penetration temperatures based on average attack.

that it would be necessary to introduce a mechanical restraint to the fuel elements. This reinforcement was effected by means of a core tube nest, the arrangement of which is shown in Fig. 3. It is constructed from a series of long and short tubes which interlock. The long tubes locate in counter-bores in the top and bottom plates. Side plates are fitted enclosing the tube nest, the whole is positioned and within the core skirt as a complete unit forming a continuous diaphragm at the core centre. As a further precaution against bowing at the centre, the tubes are pre-bowed by 0·04 in away from the centre of the reactor.

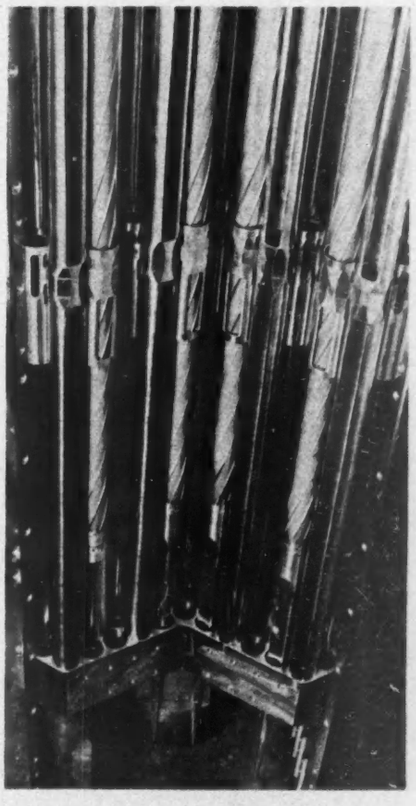


Fig. 3 Core tube nest, showing interlocking of long and short tubes in the general core assembly.

Control System

Reactivity is controlled by moving groups of fuel elements in and out of the core. There are 12 such groups each containing 10 fuel elements. At a later stage in design three boron 10 neutron absorbing rods clad in stainless steel were introduced as alternative emergency shutdown devices. They are normally held above the core by mechanisms located in the top shields, and when required they fall in under gravity. Out of the 12 rods, six operate as control rods, embracing 3·6 per cent of the reactivity; four as shut-off rods controlling 2·4 per cent reactivity and two as safety rods controlling 1·2 per cent reactivity. An electromechanical drive is used in preference to an entirely mechanical system to overcome the gas leakage problem. Owing to irradiation and temperature difficulties, it was impossible to use conventional lubricants, and therefore the drive is designed to run dry at approximately 100° C.

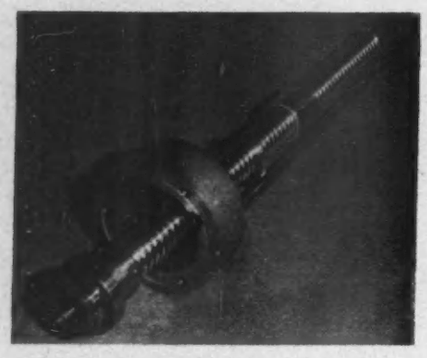


Fig. 4 Control mechanism screw assembly.

Control Unit Failure During Wet Testing

A major problem arose with the control units during wet testing owing to a defect in the mechanism for lowering the horizontal arm. The unit was stripped and decontaminated and repaired. Following the failure of six control units to move normally, it was found, by slipping the electromagnetic clutch at a torque of 15 lb-ft, that there was some added resistance somewhere in the drive. The positioning of the equipment with respect to the liquid metal is such that the thrust head is above the liquid-metal surface during normal operation, but below the level after the complete mechanism has been dropped during a trip or emergency shut-down sequence. The nut on the screw (see Fig. 4) may be above or below the surface, depending upon the control unit position. There was every likelihood of the pick-up of scum from the metal surface by the thrust head and the nut and screw.

Remedy

The incrustation has now been broken in the centre by the removal of the splined shaft. Use of a direct drive splined-shaft at a torque up to 30 lb-ft in most cases resulted in the freeing of the screw, allowing it to rotate subsequently with the application of a more normal torque of 1 lb-ft. A splash plate was also fitted to prevent liquid metal being forced into the bottom splined shaft bearing during later stages of screw raising. Further trouble was encountered following automatic trips and dropping of the control units out of the core. It was found that the bottom end of the control rod carrier which bears the fuel elements had jumped out of its location in the horizontal arm of the mechanism, and had to be removed and replaced, and in one case modified.

Electromagnetic Pumps

The electromagnetic pumps have proved very satisfactory but for the future it would be desirable to increase the size, and a rate of 6,000 gallons per min is being considered instead of the present 3,000 gallons per min. The size of the pumps is partly responsible for the complexity of the external circuits and the need to have so many circuits. An increase in size of the stainless steel duct would greatly affect the robustness of the system. There is also a problem of removing the heat generated in the windings. These factors may lead to the use of a mechanical pump which has, in addition, a much higher efficiency—about 75 per cent as against 40 per cent.

Liquid Metal to Water Heat Exchangers

Sodium-potassium reacts violently in contact with water and it was decided to construct heat exchangers such that a leak of sodium potassium or water, if it occurred, could be detected before the two liquids actually came into contact. It was therefore decided to have the sodium-potassium and water or steam flowing in separate tubes connected by a good heat-conducting material which also provided a leak path to atmosphere. The first method attempted was to cast an aluminium block round the stainless-steel sodium-potassium and water tubes, aluminium being chosen because it has good thermal conductivity and approximately the same coefficient of expansion as stainless steel. Several elements were made and tested in a sodium-potassium rig, but this method had the disadvantage that a good bond of stainless steel to aluminium could not always be guaranteed and consequently a consistent overall heat transfer coefficient could not be obtained.

The method of construction finally adopted for elements of the heat exchanger was to braze the stainless steel tubes to 8 ft long packs of $\frac{1}{4}$ in thick copper laminations. This result was achieved by assembling a pack of laminations in a holder, coating the tubes with flux and spirally winding them with strip brazing foil. However, the capital cost of this exercise was prohibitive.

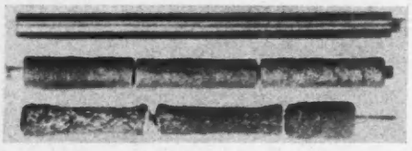


Fig. 5 Three magnesium-reduced uranium annuli, thermally cycled through the α-β transformation temperature.

Thermal Cycling

No alteration has been observed in the shape of single uranium crystals on thermal cycling. The changes are attributed to the effect of differential expansion between differently orientated neighbouring crystals in combination with a change in the deformation mechanism at low and high temperatures, for example, from slip or twinning to grain boundary flow. Eradication of preferred orientation almost completely eliminates thermal cycling effects in fine grain structure. Fig. 5 shows the changes that can overtake uranium on irradiation. It is seen that there is a tendency for the slugs to separate—a dangerous effect, since under certain conditions they could revert to their original position resulting in a large power surge. The chosen solution was to lock the fuel segments to each other and at the bottom of the can as indicated in Fig. 1.

Irradiation Growth and Swelling

In cast uranium where the grains are randomly orientated, changes in dimensions do not occur, but if the grain size is large, the unequal growth of individual grains at and near the surface produces a surface roughening known as "wrinkling." Thus the grain size must be kept to the order of 1 mm diameter. Another problem is the swelling caused by the fission product gases which becomes predominant above 450° C and was aggravated by thermal cycling. Large volume changes can be produced depending on the degree of burnup. Radial expansion is prevented by the strength of the can and space for longitudinal development is allowed for. It is seen that the fuel can plays a vital role.

Physics Calculations

Fig. 6 shows the neutron spectrum predicted at the centre of the Dounreay Fast Reactor by the Carlson S_N method. Good agreement has been obtained with the theoretical predictions and the actual measurements that it has so far been possible to check. Difficulty has occurred in making correct estimations at the core edge. The error in the prediction of critical reactor loading was very small and also of the reactivity controlled by the control rods.

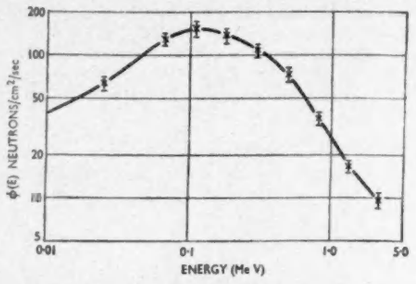


Fig. 6 Predicted neutron spectrum at the centre of the core.

New Core Configuration and Future Tests

Recently a core of modified configuration has been placed in the reactor. More experiment is necessary to ensure that the control rod problem has been overcome. The question of gas entrainment still lingers on and requires further investigation. Entrainment became apparent in earlier tests when the main circuit flow rate was increased to about 70 per cent of maximum flow in those circuits where the by-pass circuits were blocked. It is expected that the reactor will be running at about 10 to 15 MW by this time next year.

Plants of the Future

Steps are being taken for the initial studies to be made on a prototype reactor evolved from the basis of experience at Dounreay. It is hoped that this plant will be in operation in the late 1960's, and according to Dr. R. Hurst of the UKAEA, the entry of a fast reactor into the civil power programme may be expected in the 1970's. It is certain that the future reactors will be simpler—points that are open to question are the 24 external circuits and the exorbitant capital cost of the heat exchangers. The optimisation factor, particularly with regard to enrichment, is not fully understood, but the use of computers is playing an increasing part. A downward trend in fuel dilution seems to be indicated and it is anticipated that there will be a reduction in capital costs. The fuel costs will be dominated by the fuel inventory, but the consumption costs are low. The introduction of plutonium may bring problems as serious as those presented by ceramics—or more so.

References to Fast Reactors

A cumulative list of references to fast reactors was given in ENGINEERING, vol. 187, page 336 (13 March, 1959). References since that date are as follows.

Core skirt fabrication, Dounreay 20 March '59, p. 366; Melt-out containment 3 April '59, p. 427; Instrumentation for Dounreay 17 April '59, p. 491; BR-2 details 21 Aug. '59, p. 63; Russian fast reactor 21 Aug. '59, p. 63; Dounreay operation commenced 21 Aug. '59, p. 64; Dounreay delay 23 Oct. '59, p. 380; Complementary with high temperature gas cooled type 13 Nov. '59, p. 471; Bomb method of control at Argonne 30 Nov. '59, p. 503; Dounreay goes critical 30 Nov. '59, p. 503; Argonne 11 Dec. '59, p. 607; Neutron shields 26 Feb. '60, p. 292; New fast critical facility commenced 22 July '60, p. 119; Breeding fast reactors 5 Aug. '60, p. 183; Fuels for fast reactors 12 Aug. '60, p. 216; Rapsodie 14 Oct. '60, p. 512; Russian sodium cooled mark BN50 18 Nov. '60.

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(*Reference* 135/60*E*).

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(*Reference* 138/60*E*).

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New laboratories and equipment provide excellent scope for teaching and research.

Forms of application and other particulars may be obtained from the undersigned with whom applications should be lodged not later than 31st JANUARY, 1961.

ROBT. T. HUTCHESON,
SECRETARY OF UNIVERSITY COURT.

D 615

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

AIR MINISTRY require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEER for design construction and maintenance of installations on airfields, radar stations, missile bases, workshop and maintenance units for the R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to max. £1260 with increase for London and slight decrease for country districts. Appointments long term with promotion and pension prospects. Five-day week with 4 weeks 2 days leave a year initially. Special allowances payable in addition to salary during overseas service.

Minimum qualifications and experience:—

(i) (*a*) University degree or equiv. diploma in electrical and/or mechanical engineering with at least 2 years apprenticeship; or

(*b*) Graduate or corporate member of I.E.E. with at least 3 years apprenticeship; or

(*c*) Graduate or corporate member of I.Mech.E. appreciable electrical engineering experience with at least 3 years apprenticeship; and

(ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45.

Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.158/OA. G 897

THE UNIVERSITY OF LIVERPOOL

Applications are invited for IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS IN PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY or any related subjects. Appointments will date from 1st October, 1961. The salary will depend upon qualifications and experience, but will normally be within the range £700-£1000 per annum, together with F.S.S.U. benefits and family allowances.

Applications, three copies, stating age, details of qualifications and experience, publications, and research work in progress and completed, together with the names of two referees, should be received not later than 11th FEBRUARY, 1961, by the Registrar, from whom further particulars may be obtained. (Candidates overseas who find it more convenient to do so may send one copy only by air-mail.) Rev. CV/E. D 606

AIR MINISTRY

AIR MINISTRY, Works Design Branch, requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—

(*a*) Roads, pavements, earthworks and storm-water drainage; (*b*) Foul drainage and sewage disposal; (*c*) Water supply distribution. Some site experience and possession of recognised technical qualifications an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 3746), to AIR MINISTRY, W.G.d, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 895

British Titan Products Co Ltd

has vacancies for

MECHANICAL ENGINEERS

at its Grimsby Factory

The Company is a very active and flourishing Chemical Industry of international standing and its continuing expansion offers plenty of interest and scope for Engineers on plant maintenance and construction, wherein the present vacancies occur.

Preference will be given to candidates with a University degree in Mechanical Engineering, but those with an equivalent professional qualification will also be considered. Post-graduate Apprenticeship is essential and the upper age limit for the appointments is 30.

Salaries and prospects are very attractive for men with the right qualifications. Annual Bonus Scheme and Non-Contributory Endowment Assurance and assistance for married men with house purchase and removal expenses.

Applications in strictest confidence to be addressed to:—

The Personnel Manager,
BRITISH TITAN PRODUCTS COMPANY LIMITED,
BILLINGHAM, CO. DURHAM
quoting Ref. S.17.

G 901

KING EDWARD'S SCHOOL

Witley,
Nr. Godalming,
Surrey.

ASSISTANT ENGINEER

required at co-educational boarding school.

Must be a qualified electrician and experienced in the running of oil-fired plant. Knowledge of institution maintenance work and kitchen plant an advantage.

Cottage available.

Salary £590 p.a. rising to £620 p.a. Contributory superannuation scheme.

Apply giving full details of age, experience, etc. to The Bursar.

D 627

BRUSH ELECTRICAL ENGINEERING COMPANY LIMITED

Loughborough, Leicestershire

(A member of the Hawker Siddeley Group—Industrial Division)

INDUSTRIAL APPLICATIONS ENGINEER

Due to expansion in the industrial applications field this Company has a vacancy for a SENIOR ENGINEER in the Industrial Application Section of the Electrical Rotating Machines Engineering Department. A knowledge of drives in the rubber, plastics and associated industries and of related control systems is essential. Some experience of site testing and commissioning is also desirable.

Applications are invited from fully qualified men and preference will be given to corporate members of the Institution of Electrical Engineers.

Applications, WHICH WILL BE TREATED IN THE STRICTEST CONFIDENCE, should contain brief details of experience and qualifications and should be addressed to Mr. P. A. McCaig, quoting reference: PL.9904.

Brush Electrical Engineering Company Limited,
Loughborough, Leicestershire

D 609

UNIVERSITY OF SYDNEY

SENIOR LECTURESHIP AND LECTURESHIPS IN CIVIL ENGINEERING

Applications are invited for the following positions in the Department of Civil Engineering:—

(1) ONE SENIOR LECTURESHIP IN CIVIL ENGINEERING. Candidates should have an honours degree and have had some experience of the design and construction of civil engineering works.

(2) TWO LECTURESHIPS IN CIVIL ENGINEERING. Candidates should have an honours degree in Engineering.

The successful applicants, in addition to normal teaching duties, will be required to engage in research in some aspect of civil engineering and candidates should state the particular research fields in which they are interested.

The salary for a Senior Lecturer is within the range £A2550 by £95 to £3000 per annum; for a Lecturer within the range £A1730 by 105 to £2435 per annum. In each case cost of living adjustments will be allowed. The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, GORDON SQUARE, LONDON, W.C.1.

Applications close, in Australia and London, on 31st JANUARY, 1961. D 614

AUSTRALIA

ENGINEERS. METROPOLITAN WATER, SEWERAGE AND DRAINAGE BOARD OF NEW SOUTH WALES

Applications are invited from graduates or diplomates (preferably under 30 years of age) in Engineering for appointment to the Engineering staff of the Metropolitan Water, Sewerage and Drainage Board of New South Wales. Because of accommodation difficulties, vacancies exist only for single men and married men without children.

Minimum commencing salary £A1265 p.a. for a diplomate and £A1383 p.a. for a graduate, with incremental progression, subject to satisfactory service, to £A2025 p.a. Progression beyond this rate is by appointment as vacancies arise.

The main requirement is for Civil Engineers, who have just completed training but consideration will also be given to those with some experience and to graduates and diplomates in Mechanical, Electrical and Chemical Engineering.

Appointees will be employed on the investigation, design, construction or maintenance of water, sewerage and storm-water drainage projects in the Sydney or Wollongong areas. No country service is involved.

Superannuation Scheme. Good leave conditions.

Successful applicants will be nominated for travel under the Assisted Passage Scheme. The cost of the passage is £10 per adult.

For further particulars and application forms, please write to AGENT GENERAL FOR NEW SOUTH WALES, 56, STRAND, LONDON, W.C.2, quoting No. 44/97. D 610

NATIONAL ENGINEERING LABORATORY

NATIONAL ENGINEERING LABORATORY (D.S.I.R.), EAST KILBRIDE, GLASGOW, requires EXPERIMENTAL OFFICERS/ASSISTANT EXPERIMENTAL OFFICERS, for design and development engineers in the field of Fluid Flow, Heat Transfer, Lubrication, Materials and Mechanisms. Quals.: E.O. (at least age 26). Pass degree in engineering H.N.C. or G.I.Mech.E. or equiv. A.E.O.: Scottish Leaving Certificate, with passes in 5 subjects of which 3 must be in Higher Grade, including 2 in scientific or maths. subject. Salary (Men) E.O. £1015-£1245, A.E.O. £432 (age 18)-£745 (age 26)-£920. Houses are available for married staff. Prospects of permanent pensionable posts for suitable candidates. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1. Quoting C 964/OA. Closing date 6th JANUARY, 1961. D 622

AUSTRALIA

THE UNIVERSITY OF NEW SOUTH WALES

VACANCIES FOR STAFF IN THE FACULTY OF ENGINEERING

SENIOR LECTURERS AND LECTURERS

The University invites applications for appointment to positions of Senior Lecturers and Lecturers in the following schools of the Faculty of Engineering. Applicants should be qualified to teach in one or more of the fields listed.

CIVIL ENGINEERING: Materials, structures, surveying.

ELECTRICAL ENGINEERING: Automatic control, communications, computers and power systems. (One vacancy for a Senior Lecturer exists at Wollongong, to take charge of degree instruction in Electrical Engineering.)

INDUSTRIAL ENGINEERING: Methods engineering, design, production control.

MECHANICAL ENGINEERING: Thermodynamics, theory of machines, fluid mechanics, design and drawing, servomechanisms.

HIGHWAY ENGINEERING.

For appointment as lecturer, applicants should possess an appropriate degree with honours or equivalent qualifications and have had previous lecturing and industrial experience; for appointment as senior lecturer, applicants should possess a higher degree or have published research papers evidencing their ability to lecture at post-graduate level and to supervise research programmes.

Salary ranges:
Senior Lecturer: £A2579-£A3029 p.a.
Lecturer: £A1759-£A2464 p.a.

Subject to passing a medical examination, appointees will be eligible to contribute to the State Superannuation Fund.

First-class ship fares to Sydney of appointees and their families will be paid.

Four copies of applications (including the names of two referees and quoting reference HB) should be lodged with the Agent General for New South Wales, 56, Strand, London, W.C.2, and a copy forwarded by airmail in an envelope marked "UNIVERSITY APPOINTMENT" to the BURSAR, THE UNIVERSITY OF NEW SOUTH WALES, BOX 1, POST OFFICE, KENSINGTON, NEW SOUTH WALES, AUSTRALIA, before 20th JANUARY, 1961. Applicants outside the United Kingdom and Ireland need only submit one copy of their applications to the London address. D 621

STRUCTURAL ENGINEERING DESIGN DRAUGHTSMEN

AIR MINISTRY, Works Design Branch, requires in LONDON STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 3745), to AIR MINISTRY, W.G.d, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 894

AUSTRALIA

THE UNIVERSITY OF NEW SOUTH WALES

ASSOCIATE PROFESSOR IN ELECTRICAL ENGINEERING

The University invites applications for appointment to the position of ASSOCIATE PROFESSOR IN ELECTRICAL ENGINEERING IN THE SCHOOL OF ELECTRICAL ENGINEERING, KENSINGTON.

Salary will be not less than £A3179 p.a.

Applicants must possess a higher degree and preference will be given to those applicants who have specialised in the field of feedback control systems.

The appointee will be responsible to the Head of the School for undergraduate and postgraduate courses in automatic control and will be required to initiate and direct research.

Subject to the consent of the Council of the University, Associate Professors may engage in a limited amount of higher consultative work.

Subject to satisfactory medical examination, the successful applicant will be eligible to join the superannuation scheme which provides a pension of up to £A1600 p.a.

Associate Professors are eligible for six months' study leave on full salary after three years of service, or twelve months after six years of service.

The University reserves the right to fill the position by invitation.

With the approval of the University and its bankers, married men may be assisted by loans to purchase a home.

First class ship fares to Sydney of the appointee and his family will be paid.

Four copies of applications including the names of three referees and a recent photograph of the applicant, should be lodged with the AGENT GENERAL FOR NEW SOUTH WALES, 56-57, STRAND, LONDON, W.C.2, ENGLAND, and a copy forwarded by airmail to the Appointments Section in an envelope marked "UNIVERSITY APPOINTMENT," BOX 1, POST OFFICE, KENSINGTON, NEW SOUTH WALES, before 27th JANUARY, 1961. D 618

BRITISH HYDROCARBON CHEMICALS LIMITED

(Manufacturers of Petroleum Chemicals)

REQUIRE

MECHANICAL ENGINEERS
INSTRUMENT ENGINEERS

Vacancies exist for experienced men and for young graduates in both categories.

Applicants should have 1st or 2nd class degrees (or the equivalent) in mechanical engineering (or, in the case of Instrument Engineers, electrical engineering). Experience in the petroleum chemicals or petroleum refinery industries would be an advantage but is not essential.

The Company has a continuous record of expansion and prospects are excellent. Starting salary will depend on qualifications and experience. There is a non-contributory pension scheme.

Apply with full particulars to Personnel Dept.:

BRITISH HYDROCARBON CHEMICALS LIMITED · DEVONSHIRE HOUSE MAYFAIR PLACE · LONDON, W.1 D 629

CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS NEW SOUTH WALES AUSTRALIA

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES, the State Road authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road constructions and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1325 to £A1650 per annum, with annual progression, subject to technical competence to £A2400 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the AGENT GENERAL FOR NEW SOUTH WALES, 56 STRAND, LONDON, W.C.2. Please quote NO. 44/31 when writing. D 545

COUNTY BOROUGH OF BRIGHTON EDUCATION COMMITTEE BRIGHTON TECHNICAL COLLEGE

REQUIRED AS SOON AS POSSIBLE—ASSISTANT LECTURER (GRADE B) IN MECHANICAL ENGINEERING (Applied Heat and Thermodynamics). Degree in Engineering, A.M.I.Mech.E., or equivalent essential. Teaching experience desirable.

Salary Scale: £700 by 27½ (15) plus 37½ to £1,150 (men) plus graduate and training allowances and with increments for approved research, professional or industrial experience.

Further particulars and forms of application from the undersigned, to be returned to the Principal, Brighton Technical College, Brighton, 7, within 14 days.

W. G. STONE,
DIRECTOR OF EDUCATION,
54, OLD STEINE,
BRIGHTON. D 612

UNIVERSITY OF DURHAM CHAIR OF APPLIED MECHANICS

APPLICATIONS are invited for a CHAIR OF APPLIED MECHANICS tenable in the NEWCASTLE DIVISION. This is a newly established post and will be the third Chair in the Department of Mechanical Engineering at Newcastle. The successful candidate will be required to take up duty on the 1st AUGUST, 1961, or such other date as may be arranged. Salary in accordance with the Professorial scale (£2600-£3000 a year) with family allowance and membership of F.S.S.U. Further particulars may be obtained from the undersigned with whom applications (12 copies) must be lodged not later than 18th FEBRUARY, 1961. (Candidates outside the British Isles may submit one copy only.)

REGISTRAR,
UNIVERSITY OFFICE,
46, NORTH BAILEY,
DURHAM. D 604

8th DECEMBER, 1960.

OXFORD UNIVERSITY

There is a vacancy in the University Surveyor's Office for a MECHANICAL ENGINEER to co-ordinate the design of heating, ventilating and electrical equipment and plant in new building projects. He will be responsible under the Surveyor for liaison between departments and architects and specialist consultants, and will also be required to exercise a general supervision of the maintenance and repair of existing installations.

He must be a qualified mechanical or electrical engineer, or a graduate in engineering. Salary will be in the range £1500 to £1850. The successful applicant will be entitled to membership of the Federated Superannuation System for Universities, and would qualify for children's allowances of £50 per child per annum.

Further details and forms of application from the SURVEYOR TO THE UNIVERSITY, THE MALTHOUSE, TIDMARSH LANE, OXFORD. D 603

APPOINTMENTS OPEN

ASSISTANT CHIEF ENGINEER

ASSISTANT CHIEF ENGINEER required for Engineering Office on North East Coast. The work of the Company is connected with the design and construction of industrial power stations and general mechanical/electrification work and demands a knowledgeable and keen man between 35 and 45 years of age. The applicant must be a graduate or chartered mechanical/electrical engineer used to leadership and with a good experience in Contract work. Ability to work harmoniously yet firmly with existing staff is essential.

Contributory Superannuation Scheme in operation.

Reply giving full details of present salary and previous experience to BOX D 547, Offices of ENGINEERING.

SENIOR PLANNING ENGINEER

SENIOR PLANNING ENGINEER required,(must have good all round experience in Heavy Engineering and Works Study. Write giving age, experience and other particulars to Personnel Manager, BOX D 592, Offices of ENGINEERING.

HEAD OF CONTROL ENGINEERING SECTION

A leading Industrial Research Organisation has a vacancy for a Senior Control Engineer to lead a team engaged on the application of advanced control engineering to a highly progressive industry. The post will interest men in their early to middle 30's already earning between £1500 and £1700 who are looking for a substantial increase in salary and good prospects for advancement.

Candidates we would like to hear from are those with a good Hons. Degree in Engineering or Physics, some years' experience in Automation Research, an enthusiasm for stimulating and progressing the application of advanced control engineering techniques in industry, and a definite ability to lead.

Applications in strict confidence to BOX D 565, Offices of ENGINEERING.

LIL

LAPORTE CHEMICALS LIMITED

(a member of the Laporte Group of Companies)

require

SECTION LEADERS

for interesting work on large chemical plant installations. Candidates, aged between 30 and 40 years, should be experienced in plant layout and vessel design and familiar with British and American Codes of Practice. They should be first class men of H.N.C. Standard, capable of controlling a section of draughtsmen and working under the direction of a Project Engineer.

The positions are permanent and attractive salaries will be offered to the selected applicants. Modern offices situated in the London E.C.4 area. Five-day week and superannuation scheme. Applications will be treated in the strictest confidence.

Details of age, qualifications and experience, and quoting reference LCL/E2/82 should be sent to the Group Personnel Manager, **LAPORTE INDUSTRIES LIMITED,** Hanover House, 14, Hanover Square, London, W.1. D 625

Millars'

MACHINERY CO. LIMITED

invite applications for the position of

DESIGN DRAUGHTSMAN

for Development work on Hydraulic pumping equipment.

This position offers excellent opportunities for a man with suitable experience.

A Pension Fund and Life Assurance scheme is in operation.

Apply in writing giving details of age and experience to:—

Personnel Manager
MILLARS' MACHINERY CO. LIMITED
THORLEY WORKS,
BISHOP'S STORTFORD, HERTS.
D 624

CHARTERED ELECTRICAL ENGINEER

A vacancy exists for a chartered electrical engineer with an Hydro-Electric Power undertaking in Northern Nigeria. Pleasant climate, 4000 ft. above sea level. Age 30 to 35. Salary grade £1335/£1565 according to age, qualification and experience. Pension and Life Assurance Scheme. Eighteen months tours with three months' leave on full salary. Free furnished quarters. Free passages self, wife and two children, or equivalent benefits if children remain at home.—Write BOX E.996, c/o STREET'S, 110 OLD BROAD STREET, E.C.2. D 594

AEI

Associated Electrical Industries Limited

SYSTEMS ENGINEERING DEPARTMENT

There is an excellent opportunity for experienced graduate APPLIED MATHEMATICIANS and ENGINEERS with sound mathematical training who have a marked aptitude for research work to join a team engaged on non-routine long term investigations arising from the application of COMPUTERS to a wide variety of engineering problems.

The facilities available include a Ferranti MERCURY computer and a large scale PACE analogue installation.

Every encouragement will be given to publish the results of work done and there are also opportunities to take part in a variety of "Extra-Mural" activities involving lecturing and organising courses in a variety of subjects connected with the work of the Department.

The usual staff benefits apply, including a first-class Pension Scheme, and naturally salaries commensurate with the nature of the work involved and the merits of successful applicants will be offered.

Write, *in confidence*, giving full details of career to date, with present salary, quoting reference P.17 to:—

Personnel Manager
Associated Electrical Industries (Manchester) Limited
Trafford Park, Manchester, 17. D 628

The OSRAM LAMP DIVISION of the General Electric Co. Ltd.,

has the following vacancies

(a) DESIGN ENGINEERS & DESIGNER DRAUGHTSMAN

To join group engaged in the design of special purpose machinery and fine mechanisms for mass production of light engineering products. The work is interesting, gives scope for initiative and has excellent prospects. Applicants should have a minimum of H.N.C. Mech. Eng., and preferably some experience in mechanical design.

(b) DETAIL DRAUGHTSMAN

This vacancy has arisen on similar type of work. Applicant should have O.N.C. Mech. Eng., and preferably drawing office experience.

These appointments are permanent and pensionable for the right applicants.

Applications, giving full particulars of experience and qualifications, should be sent to:—

The Senior Personnel Officer,
OSRAM LAMP DIVISION,
G.E.C. Estate, East Lane, North Wembley, Middlesex

D 611

THE MOND NICKEL COMPANY LIMITED

requires

for development work in the ferrous field

STEELMAKER-METALLURGIST

with full practical melting-shop experience in the production of alloy steels, preferably including the austenitic stainless types. University degree or equivalent advantageous. The successful candidate will be located in London, but his duties will include foreign travel. Pension and assurance schemes are in operation and, in appropriate cases, assistance can be given for housing.

Applications, which will be treated in confidence, should give details of age, qualifications, experience, salary required, etc. They should be addressed to

THE GENERAL MANAGER,
DEVELOPMENT AND RESEARCH DEPT.,
THE MOND NICKEL COMPANY LTD.,
THAMES HOUSE, MILLBANK,
LONDON, S.W.1.

Please mark envelope 'Confidential D.33.'

D 569

MECHANICAL ENGINEER

MECHANICAL ENGINEER. Opportunity occurs for Graduate or Corporate Member of the I.Mech.E. between 35 and 40 years of age, to assist in the Management of a large progressive old established mass production engineering works in the North Midlands. The Company is of international repute with several factories and produces a high precision product. Candidates must have had first-class production experience, possess personality and tact and be capable of fitting into and taking part in the management and production administration of a large modern organisation. Good opportunity for a candidate who can measure up to the above requirements. Good conditions and pension scheme.—Reply, stating age and full particulars of experience and qualifications and salary expected, to BOX D 602, Offices of ENGINEERING.

SENIOR MECHANICAL ENGINEER

SENIOR MECHANICAL ENGINEER. A large light precision Engineering Company situated in a pleasant area of the East Midlands, requires a senior engineer in the Technical Department. The work involves design contact with customers engaged in a variety of engineering industries relating to the use of the Company's products. This is a senior appointment and there are good opportunities for advancement. An excellent pension scheme is in operation, together with good working conditions and recreational facilities. Applicants should have a degree in Mechanical Engineering or equivalent professional qualification, general design experience, and be under 40 years of age.—Applicants, giving age, education, qualifications, experience, and salary required, should be sent to BOX D 601, Offices of ENGINEERING.

Another Opportunity in Iron & Steel

BISRA

AUTOMATION RESEARCH

The Steel Industry is a highly progressive basic industry which offers great scope for application of automation. Research work on this subject is conducted at the BISRA London Laboratories by groups working on Operational Research, Complex Control System Design, Control Engineering, and Instrument Research. There are vacancies for staff in several of these rapidly developing groups which offer young men opportunities to do very interesting basic and applied research and to advance themselves professionally by publication of work and participation in the activities of Learned Societies. Applications are invited from candidates with a good degree in Science, Engineering or Mathematics and some experience in research on Instrumentation, Control Engineering Information, Handling Technology, or Complex System Control. Vacancies exist for staff in the commencing salary ranges up to £1500 per annum. Posts are superannuated under the F.S.S.U.

Written applications only quoting 'P.E.C.1,' to the Personnel Officer, The British Iron and Steel Research Association, 11, Park Lane, London, W.1. D 564

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANT required in the London Office of Norman & Dawbarn, Architects and Consulting Engineers, for Civil Engineering work associated with various building projects including airports and factories. Age preferably between 25 and 35. Written applications must give age, experience, qualifications and salary required, to: NORMAN & DAWBARN, 7, PORTLAND PLACE, LONDON, W.1. D 617

SENIOR DESIGN DRAUGHTSMAN

SENIOR DESIGN DRAUGHTSMAN with H.N.C. (Mechanical), Chemical Works experience and a practical outlook, required in Cambridge to take charge of small Drawing Office. Salary range £1000-£1250 p.a. according to age and experience. Pensionable post, five-day week. Full particulars (QUOTING No. 1593) to PERSONNEL MANAGER, FISONS PEST CONTROL LTD., HARSTON, CAMBRIDGE. D 620

VICKERS-ARMSTRONGS (ENGINEERS) LTD.

Applications are invited for the following positions in the Nuclear Power Division which is responsible for the installation of Propulsion Machinery in Nuclear Submarines.

Technicians

for thermodynamics, heat balance and general stress work. Candidates should have a Degree or good H.N.C.

Draughtsmen

for machinery and pipe system arrangement work. Candidates should have O.N.C. or M.O.T. Certificate as minimum qualification and drawing office experience on Marine work is desirable.

Development Engineers

for work in connection with investigating improved methods of design for production and installation. Candidates should have H.N.C. as minimum qualification and appropriate experience.

These positions offer scope for advancement in a new and expanding department.

Successful applicants will be required to join the Company's Contributory Superannuation Scheme when eligible.

Applications, which will be treated in strictest confidence, should give full details of age, qualifications and experience and current salary and be addressed to:—

The Manager, Nuclear Power Division, VICKERS-ARMSTRONGS (Engineers) LTD Naval Construction Works, Barrow-in-Furness, Lancashire.

D 590

SENIOR PROJECT ENGINEER

required for the Central Engineering organisation of an active and flourishing Chemical concern in the North of England with international interests.

The duties attached to the post are the direction and co-ordination of the engineering activities of a group of projects concerned with the Company's expansion at home and overseas. The post is primarily concerned with design and procurement and not directly with site work.

A wide engineering experience is essential, including Civil, Electrical and Instrument engineering, with emphasis on Mechanical Engineering Design and Chemical Plant layout.

Applicants must be University graduates in Mechanical/Electrical Engineering and have served an apprenticeship, followed by at least ten year's experience in the Chemical industry.

A salary of the order of £2500 is offered and interested Engineers who fulfil the above qualifications may write in strictest confidence to BOX D 623, Offices of ENGINEERING.

VICKERS-ARMSTRONGS (ENGINEERS) LTD.

BARROW-IN-FURNESS, LANCASHIRE

invite applications for the following positions:

HEALTH AND SAFETY OFFICER

SENIOR HEALTH PHYSICIST

These are senior appointments and the salary offered will be in accordance with the qualifications and experience of the candidate.

The Health and Safety Officer will be responsible for organising the setting up of a Health Physics Department, the preparation of procedures covering all activities involving the movement, storage and operations involving nuclear materials, and ensuring that such procedures are carried out. He will be responsible for conducting all negotiations between the firm and the various ministries and Local Authorities.

The Senior Health Physicist will be responsible to the Health and Safety Officer for all Health Physics measurements within the works and for the calibration and maintenance of Health Physics equipment.

The Company operates a Contributory Pension Fund and applications giving full details should be sent to The Manager, Marine Propulsion and Development Department at the above address. D 619

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates: per page (12 in. by 9 in.) £100
half page £54
quarter page £29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.) £100
per half page £54
quarter page £29
per single column inch .. .. £2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent, on 52.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Company Meetings

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

More and Taller Aluminium Windows

CONSTANTLY intensifying their export efforts, the CRITTALL MANUFACTURING Company reached a volume of overseas sales in the past year equal to 25 per cent of the total turnover.

Despite increasing labour costs and rising prices in zinc, and to a smaller extent in brass and aluminium, the group trading profit was £696,873, against £679,697 in the year before.

Any contemporary study of the differences in the buildings surrounding 20th century populations and those of, for instance, the Victorians, might well include a note on the aluminium and other window frames that have replaced the wooden frame. And many of the examples would be drawn from the products of the Crittall company.

For their future development the company is in close cooperation with CURTISA SPA, of Bologna, and with SCHWARTZ-HAUTMONT, of France. Crittall believe that the window this combined operation is producing amounts to a considerable advance.

Anticipating that the rising cost of building land will compel at least city housing to go much higher, Crittall are developing a range of windows suited to this way of building. Even higher than anything local councils and others are likely to put up in the way of city flats is the future 30 storey building in Manchester, which will be one of the tallest buildings in the country. Curtain walling and windows for the building will be provided by the company.

An informative turnover analysis is given by Lord Braintree, the Crittall chairman, with his review.

Where The Money Went

	1960 s d	1959 s d
Raw materials, supplies and services	10 11¼	10 10½
Wages, salaries, payments for benefit of employees	7 3	7 2¼
Depreciation	3¼	3¼
Taxation	8¼	9¼
Dividend	5¼	5
Retained in business	4¼	4¼
	20 0	20 0

Diverse Base for Plessey Prosperity

Fifteen per cent of the payroll of the PLESSEY GROUP goes to those working on research and development. Equally important is the fact that the company has almost £7 million standing in its accounts against cash and investments and another rights issue recently in hand to raise an extra £9¼ million. A first claim on these funds is the expansion of manufacturing capacity to put into production the results of the work of the Plessey research and development laboratories.

Second and third targets of the directors are the purchase of related businesses to strengthen the company's range and to set up subsidiaries overseas, particularly in the European Common Market and the British Commonwealth.

Plessey products range through an extensive list, taking in missile power packs, atomic detection gear, piezo-electric transducers, vibrators, telemetry equipment and sintered metal products among a host of others. It is this diversity which makes it possible, in times when prosperity is appearing a little patchy, for Plessey to report that after a sharply increased profit last year, their profits in the first four months of the current year show no sign of being materially different from those of a year ago.

The group profit before tax has risen to £4,300,884 (from £2,236,119 in the year before). All three British armed services use Plessey communications equipment and substantial orders have come in from other NATO forces, among them the Netherlands Navy and Air Force and the Canadian Army. The contract for the Canadian army, worth $5 million, was believed to be the largest single order ever placed for British VHF communications equipment.

Operating about 65 licensing agreements with overseas companies, Plessey have concluded an agreement with the WESTINGHOUSE CORPORATION under which the Westinghouse aircraft electrical generating system is manufactured in Britain. Westinghouse-Plessey equipment of this type will be fitted to the Vickers VC 10.

Reconstruction of a Famous Company

Appearing for the first time as those of a holding company, the report and accounts of the FAIREY COMPANY provide an opportunity to observe how the reorganisation of what was one of the most famous of Britain's airframe companies has been going on since the sale of FAIREY AVIATION LIMITED.

The Heston and Stockport factories of the Fairey engineering interests are grouped under the subsidiary company, FAIREY ENGINEERING Limited. Atomic engineering, weapon and target aircraft activities, hydraulics and the Fairfin division are carried on in these works.

In association with ATOMIC POWER CONSTRUCTIONS, the nuclear section is at work on the Trawsfynydd power station, North Wales. Following the experience of other companies in this field, and the perhaps somewhat rueful reports of their chairmen, the value of this work to Fairey is at present being treated with great reserve.

The hydraulics division has a good order book and expansion into other fields of hydraulic activity is being carefully examined.

Even before the disposal of Fairey Aviation a vigorous member of the Fairey team was FAIREY AIR SURVEYS Limited. Now it continues its expansion at home and abroad. The company research division is widening its activities and for the third successive year Fairey Air Surveys are working on a photographic contract in Burma.

An important step forward in the Fairey diversification was the purchase of the old-established diving equipment company, SIEBE, GORMAN & Company. In addition to their diving engineering interests Siebe, Gorman manufacture a wide variety of industrial safety equipment, including safety helmets and advanced types of breathing apparatus. The export activity of this new member of the Fairey group is well advanced.

In its own overseas organisation Fairey has subsidiaries in Canada, Australia and Belgium. The Canadian company has built a large hangar at the International Airport, Halifax, Nova Scotia. It is believed that increasing possibilities in the aviation business of North America are opening up for this subsidiary.

FAIREY AVIATION OF AUSTRALASIA, with facilities at Bankstown and Adelaide has an increasing turnover in aircraft, and in their other fields. Plans are being considered for further expansion.

In Belgium, AVIONS FAIREY SA has had something of a difficult year due to the Congo troubles. A start had been made on important contracts for the production of Star fighters for NATO forces. After the Congo disaster this work was temporarily stopped with unavoidable losses. The work has now been resumed and negotiations are going on with the Belgian Government.

Camberley Day at Garringtons

Few firms are more active than GARRINGTONS, the Bromsgrove, Worcestershire, engineering and tool making company, in showing visitors from

home and overseas what they do and how it is done.

One of their most recent efforts was to show army officers from ten countries round the Bromsgrove works. The military team had come from the Staff College, Camberley, Surrey, where officers of about the rank of major study for a year and include an industrial tour in their activities.

Garringtons, producing more than 100 million items for the vehicle, aircraft and other engineering industries every year, are obviously a vantage point from which those in other fields can be shown something of what manufacturing industry is about.

The nations represented by the party of officers were France, the United States, Australia, Nigeria, Canada, Ghana, Malaya, India, Pakistan and the Central African Federation.

Mr. H. Orford, a director and manufacturing manager, on the right in the picture, accompanied part of the group on its tour explaining points of manufacture and application.

EMI's Capital Swings and Record Roundabouts

It is one of the inevitable facts of economic life that when people are prevented by credit restrictions from so easily purchasing substantial items like washing machines and radiograms they turn instead to humbler ways of spending the money, increasing, for example, their buying of records.

ELECTRIC AND MUSICAL INDUSTRIES is directly affected by this pattern. About half of the group's turnover in the year ending 30 June (total sales £69 million) was accounted for by gramophone records. This is rather higher a percentage than before the war.

The rest of the company's products are spread through the capital goods industries in the manufacture of electronic equipment, including control gear for machine tools, radio and television, domestic electric appliances, magnetic tape and some office equipment.

Sir Joseph Lockwood, the chairman, makes the point in his annual report that expansion and development of new products takes time as well as money. Quicker results can sometimes be obtained by buying another business which itself benefits from becoming a member of a larger group.

In EMI's case there is the interesting example of the speed with which the group was able to develop its interests in the North American market in gramophone records by the purchase of CAPITOL RECORDS INCORPORATED. This brought to EMI a varied repertoire and to Capitol the chance of speedy expansion through EMI's catalogues and international coverage.

Blankets and Dryers

At home the acquisition of MORPHY-RICHARDS, in the domestic appliance field, is a similar case, if in another field. With sales worth £12 million in the last financial year, the Morphy-Richards history is in itself one of the outstanding examples of the growth of the United Kingdom's electric appliance industry. The company counts electric irons, toasters, blankets, spin dryers, refrigerators and hair dryers among its products.

EMI, one of whose public faces is that of HMV, has also, appropriately for a company largely associated with recorded and broadcast sound, acquired ARDENTE Limited and ARDENTE ACOUSTIC Laboratories, whose name is to some people almost synonymous with hearing aid equipment.

The EMI industrial division now produces a number of simplified controls which carry a machine tool to a succession of chosen positions, a separate and distinct function from the more refined process of contouring.

The export side is prospering too with the EMI ELECTRONICS Company, which has doubled its overseas sales in 12 months.

Some interesting applications have come up for the instrument division. Closed circuit television has been installed by the police to watch the traffic at some intersections. It is also being used by a London advertising agency to study in advance the possible impact of television commercials. On Wall Street a stockbroking firm has put in closed circuit in order to bring up-to-date price movements to the desks of members of the staff.

Sir Joseph Lockwood is not optimistic about the general prospect. He believes that the pace of economic expansion is slackening almost everywhere and that a measure of recession may be seen soon in many parts of the world. Despite this overall view he is confident that a small general increase in the group's turnover will take place during the current year.

Rolls-Royce Avon RA.29 Jet Engine

The Avon jet engine as applied to Comet IV's and Caravelles is an outstanding example of success achieved by painstaking research and perfection methods in design and manufacture.

IN THE design of most engineering products there is considerable freedom because it is difficult to formulate a precise specification of the users' requirements. In the design of an aero-engine, the requirements are exacting and precise. The result is engineering of the highest order. The more closely you can define the product you are about to design, and the more rigid the conditions imposed on it, the better.

Since the aero-engine is only a component of an aircraft, though a most important one, both the airframe designer and the aircraft operator have a special interest in its design. Even so, the development and manufacture of aero-engines is a highly specialised business. The Rolls-Royce Aero Engine Division employ over 35,000 people.

The close definition of aero-engine design stems from a number of extremely severe restrictions. Bulk, frontal area, power-to-weight ratio and reliability are all important, and in the case of a civil engine such as the RA. 29, fuel economy, long overhaul life and low overhaul cost are additional factors. These restrictive features are probably more severe than for almost any other engineering product.

A further condition of success for an aircraft engine is that the basic design must be capable of successive development to provide increased thrust. Also, the accessory layout must be variable to suit a wide range of aircraft applications. If these two conditions are not met, then comparatively few will be sold due to the rapid advance of aircraft design, and it will not be possible to spread the exceptionally high research and development costs satisfactorily.

GAS-TURBINE ENGINE

For normal aircraft, excluding those of the VTOL and STOL types, gas-turbine engines may be divided into three groups, the turboprop, straight turbojet like the Avon, and bypass turbojet. The turboprop, in which the rotating assembly drives a propeller, finds favour for aircraft with a cruising speed less than about 450 m.p.h. Above this figure the jet engine shows superior efficiency as a propelling unit. For increased power-to-weight ratios the future lies in the bypass or ducted fan engine. The Rolls-Royce Conway bypass engine, a descendant of the Avon, has already reached a thrust of 20,000 lb.

The early history of the gas turbine engine for aircraft started when Dr. A. A. Griffiths joined Rolls-Royce in 1938 to continue his work on the development of the gas turbine engine. Under pressure of events during the Second World War, Rolls-Royce and the Rover Company both became associated with the development of the Whittle gas-turbine engine. In 1943 Rolls-Royce acquired direct responsibility with Sir Frank Whittle for developing and producing Britain's first production jet engine, and at the same time the Rover Company took over the task of producing the Meteor tank powered by a development of the well-known Rolls-Royce Merlin piston engine.

DEVELOPMENT OF THE AVON

The first production gas-turbine engine was the Welland, introduced towards the end of the, war, followed later by the Derwent and the Nene all with compressors of the centrifugal type. However, Rolls-Royce engineers were not long in realising that the future lay in the more efficient axial flow compressor, and the Avon family of engines is the direct result of development along these lines.

In 1945 design work started at Barnoldswick on a 13,000 lb thrust engine with a 2-spool axial compressor for a projected light bomber (which eventually emerged as the English Electric Canberra). The idea of a single jet engine was soon discarded due to its imposition

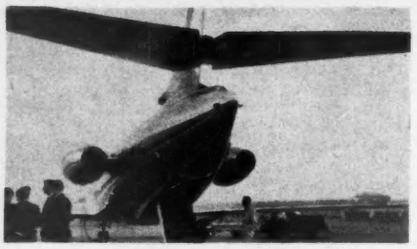


Fig. 1 The best-known civil Avon applications, the Comet IV (upper) and the Caravelle (lower).

on the design of the fuselage, in favour of two wing-mounted engines. The thrust requirement was accordingly halved and the engine which finally resulted had a single shaft axial compressor. It was, in fact, the first Avon prototype. The new engine became known as the RA. 1. Its compressor had 12 stages of constant mean diameter, and the turbine had a single stage. The pipe chamber combustion system was similar to that of the Nene.

The RA.1 first ran on test in the spring of 1947, but it soon ran into trouble. It was unable to develop the design thrust, nor could it attain the intended SFC (specific fuel consumption) of 0·89 lb per hr per lb thrust, due to an oversize compressor and low turbine efficiency. Consequently the RA.2, which first ran ten months later, had a compressor of smaller capacity and variable inlet guide vanes. This version, which developed 6,000 lb thrust, was the first to fly, being installed in the outer nacelles of an Avro Lancastrian transport in place of the normal Merlin engines, and was shown at the SBAC

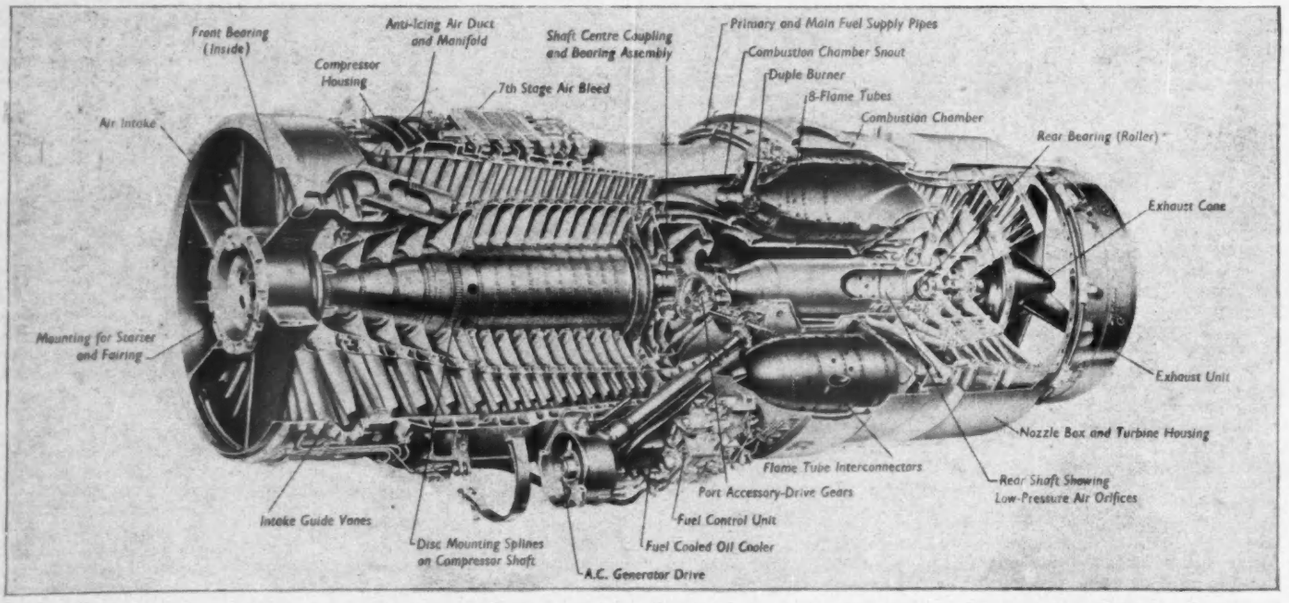


Fig. 2 Cutaway view of the Avon RA.29, port side. Fuel pump and intake guide vane ram are on opposite side.

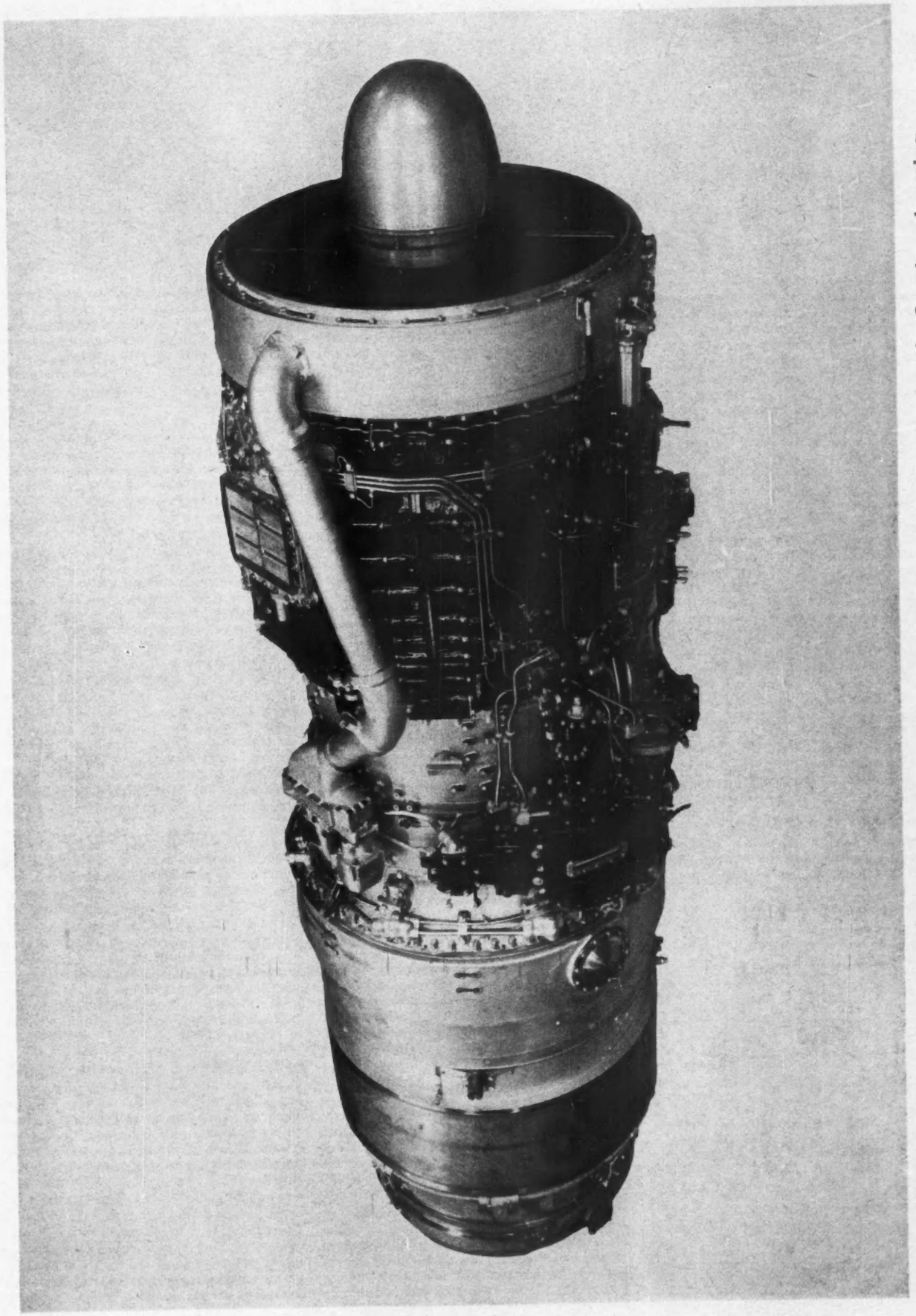


Fig. 3 The most exacting requirements and the most rigid specification lead to the finest engineering.

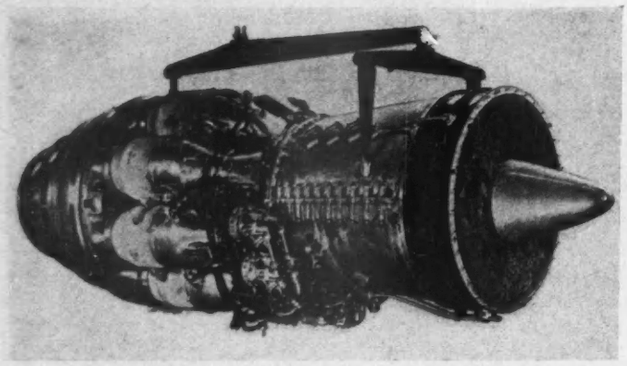


Fig. 4 (left) One of the early prototypes, the RA.1.

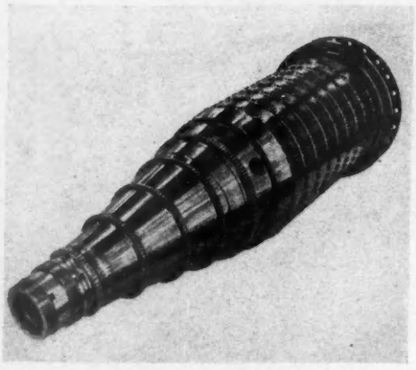


Fig. 5 (right) Compressor shaft of the RA.29.

display at Farnborough in 1948.

About this time Avon development was transferred to Derby. Then came the RA.3, the first Avon to go into production. This engine had a 2-stage turbine of smaller diameter, and was the first Avon to pass its type-test at the full 6,500 lb thrust. It was lighter than the RA. 2 and this engine actually went into the Canberra. Modifications to the RA.3 soon brought the thrust up to 7,500 lb in the RA.7, which was built in large numbers by several firms to meet the demands of the RAF abou. the time of the Korean war.

Up to now Rolls-Royce had been selling the Avon to a purely military market, but they realised that the future of both the engine and the Aero Engine Division really lay in the civilian field. Doubts were expressed as to their chances in this sphere, but a civil version of the RA.7, de-rated to 6,500 lb and known as the RA.9, was tried in the prototype De Havilland Comet II. The RA.9 started the 500 series, as it was called, which embraces all past and present civil Avons. It was successful, and so production Comet II's had a more powerful version, the RA.25, with a thrust of 7,300 lb. They were the first civil jet airliners to enter service in the world.

In the meantime the RA.7 had developed in a military direction into the RA.28. This engine had a direct civil counterpart, the RA.26, with a thrust of 10,000 lb. These engines departed from the earlier ones in having a re-designed compressor with 15 stages and the can-annular combustion system of all subsequent Avons.

COMET IV AND CARAVELLE

The RA.26 went into the prototype Comet III, but before it could be fitted to any production models all Comets were withdrawn from service due to the unfortunate series of airframe accidents, resulting in destruction tests by the RAE at Farnborough that became recognised as classic in aircraft design history. Rolls-Royce now asked themselves, should they stick to the same engine for future Comets, or should they pursue further development? They decided upon the latter course and the time lag during the RAE investigations was used to develop the RA.29. This engine produced 10,500 lb thrust and was designed specifically for Comet IV production aircraft. The continued military development of the Avon will now be left aside.

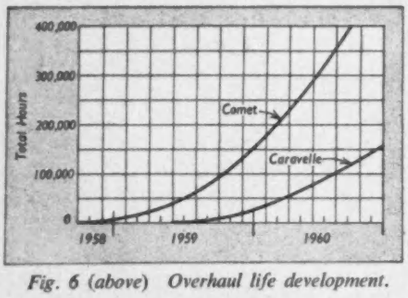
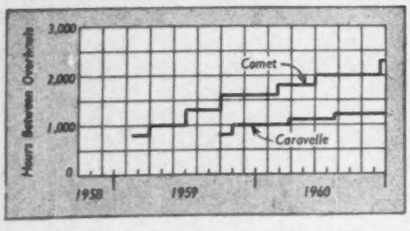


Fig. 6 (above) Overhaul life development.

Fig. 7 (below) Total engine hours in service.



In developing the RA.29 Rolls-Royce aimed principally at reducing the SFC and thus make the turbojet aircraft a more attractive proposition to an airline operator than it had been up to that time. During the RA.29's type-test in March, 1957, the SFC developed was 0·760 at take-off conditions, which indicates the measure of success in that direction. The principal design modifications involved the addition of a compressor stage and a new 3-stage turbine.

The RA.29 went into regular airline service in the Comet IV in October, 1958, on BOAC's transatlantic routes. Since then many other airlines have bought Comets and the Avon has become firmly established all over the world.

The other well-known application of the Avon RA.29 is by Sud-Aviation in their Caravelle machine which first entered airline service with SAS in May, 1959. Unlike the Comet which has four " buried " engines in the wings, the Caravelle has only two engines and they are " pod " mounted one on each side of the fuselage at the rear. The RA.29's are to all intents and purposes identical in the two machines, although the accessory layout differs. Also, in the later Stage 3 Caravelles they are uprated to 11.400 lb for take-off by means of a 2-position nozzle.

OVERHAUL LIFE

When the RA.29 first entered service with the BOAC it had an overhaul life of 1,000 hours, being the first turbojet engine in the world to enter service at this figure. The " overhaul life " characteristic is of paramount importance to an airline, since it provides a basis for comparing maintenance costs as well as representing a function of proved reliability. Overhaul life is the flying time allowed a particular type of engine, barring mishaps, before it must be removed from the aircraft for dismantling, inspection and replacement of any worn parts. To extend the life of an engine, agreement must be reached with the airworthiness authorities. In Britain this is only granted after a few engines selected at random amongst aircraft in service have been allowed to over-run their overhaul time by a specified period. And during the ensuing strict scrutiny the condition of all the components must be found satisfactory.

Thus the overhaul life of a successful engine increases in steps throughout its period of active life. Fig. 6 shows how the overhaul life of the Avon RA.29 has increased in both Comet and Caravelle applications. Today it has reached 2,300 hours, with life extension trials to 2,600 hours on the Comet. This is a fantastic achievement, and the RA.29 represents a major step forward in the use of turbojets in airline service.

Just as important to an airline is the RA.29's remarkable freedom from shutdown due to engine defect within the permitted overhaul life. The BOAC found that in the first two years of operation the shutdown rate averaged 0·04 per 1,000 engine hours, compared with a general average of about 0·5 for all other turbine engines. Another attractive feature of the RA.29 is the small amount of attention required between overhauls. Basically, refuelling, checking oil levels and filters, and examining the air intake for signs of debris damage are all that is required.

Rolls-Royce traditions of a comprehensive service organisation are fully maintained by the Aero Engine Division. Apart from a systemised method of dealing with day-to-day problems, as well as those of a more serious nature a free school is provided at Derby for both their own and customers' staff. Portable instruction kits can be flown out to any part of the world to give instruction on the spot. Permanent and travelling representatives cover the whole world.

Though Rolls-Royce assistance is readily forthcoming, the larger airlines are given every encouragement to carry out their own overhauls.

THE FUTURE OF THE AVON

While there has been no call for increased thrust on the part of the Comet, which is more than adequately powered with its four RA.29's, it is a different story with the Caravelle with only two. The process of gradually up-rating is likely for some time to come. A version giving a maximum take-off thrust of 12,200 lb is planned for fitting to the Stage 6 Caravelle starting next year, followed by another developing 12,725 lb. These further thrust increases have been achieved principally by using 17 instead of 16 compressor stages.

Rolls-Royce recently stated that they have sold turbine engines for powering over 1,000 civil aircraft throughout the world, out of a total of approximately 1,800 such aircraft. Roughly 15 per cent are Avon RA.29's and of these about 80 per cent have been exported. On the basis of sales figures alone the position looks healthy, but such is not the case. Research, development and launching a new aero engine now costs around £20 million, and to maintain their lead in the aviation field the firm have called for Government support. Thus when the Avon is obsolete, the impressive operational experiences gained with this remarkable engine, in particular the RA.29, can be used to the full in its successors.

Tyres to Survive the Stress of Racing

The race track is a test bed that can concentrate months of experiment into a few gruelling hours. Tyres designed to survive these conditions may also bring greater safety to the roads.

By Brian Lister

CAR manufacturers who nowadays take part in motor racing do so in general for two reasons: first, for prestige; second, and today the far more usual reason, because there is money in it.

Admittedly, it is virtually impossible for the major companies—or independent anateurs—to make a profit from the sport. But many smaller companies depend on racing for their main source of income, drawing it from fuel companies, accessory manufacturers, and circuit organisers.

Is it therefore no longer true that racing improves the breed? Nowadays only the accessory manufacturers who support motor racing can benefit in this way, the makers of tyres, brakes, brake linings, dampers and so on. Even they could achieve the same results by other means; but the high pressure under which development takes place on the test bed of the race track, telescopes the time required into a much shorter period.

Since the war probably the greatest single step forward in improving lap times on racing circuits the world over has come through the development of the modern racing tyre. When my company was involved in racing, the difference made by tyre development on the Lister Jaguar at the Silverstone circuit between the autumn of 1957 and the spring of 1958 was some 5 seconds, that is to say, nearly 5 per cent less time to complete one lap of the circuit. While this reduction was exceptional, it goes to show how important tyre development is to motor racing progress in particular, and at a later stage to road tyres in general.

RACING TYRE DESIGN

In principle, a racing tyre is similar to any ordinary tyre consisting as it does of five main parts: (1) a volume of air; (2) an inner tube which contains the air (in the case of all racing tyres); (3) a flexible casing; (4) a high tensile bead fitted to the base of the tyre to retain it on the wheel rim; and (5) the tread.

The racing tyre has three tasks. It must apply the power developed from the engine as fully as possible to the road, that is to say, with the minimum of slip. Similarly it must take braking loads in the opposite direction. And of course it must accommodate ultra-high cornering forces. All these loads are of a very high order as compared with loads imposed on the tyres of a normal touring car. For example, it was reckoned that it was possible to spin the rear wheels of some of the 1938 German Grand Prix cars at 150 miles an hour in top gear if the throttle was opened too quickly. Since the war the larger sports cars on the Mulsanne straight at Le Mans have touched nearly 190 miles an hour, and are then braked with modern disc braking systems within 300 yards to almost a complete stop for the hairpin at the end of this straight.

Obviously tyres working under such conditions have to be special products, but products from which lessons may be learned for the future development of the ordinary road tyre. If a company can produce tyres to last satisfactorily for 24 hours of the gruelling Le Mans race, when the above-mentioned punishment is occurring once every 4½ minutes throughout those 24 hours, they can produce a tyre running well within its limits for the 150 mile an hour touring cars that we are beginning to see today on motorways.

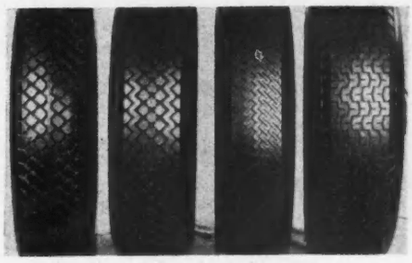


Fig. 1 Ten years of Dunlop racing tyres.

What are the problems involved in designing modern racing tyres? The chassis manufacturers call for a tyre of low weight in order to keep down the all important unsprung weight of the car, also for a small tyre so that the frontal area of the car can be kept to a minimum, and of course for good adhesion. But at the same time they will expect long tread life so that no wheel changes will be necessary throughout any particular race. The tyre should also have a low rolling resistance so that power is not wasted.

There are nevertheless special tyres for use where certain conditions apply on a given circuit. For example, on a light modern Grand Prix car the treads will be of a shallow pattern that saves weight and minimises heat generation within the tyre, but for a long-distance sports-car race a deeper pattern would be used, and a longer lasting tread material of a different rubber compound would be required.

Record breaking on the other hand calls for a completely different approach altogether. The tyres on Donald Campbell's Bluebird, the car that crashed so spectacularly recently, were 7·00-41 size as compared with the normal 6·50-15 of contemporary Grand Prix cars. It is not uninteresting to consider one of the tyre designer's main problems on such record-braking tyres. Centrifugal force is probably the biggest problem of all. To give an example, at 50 miles an hour on one of Campbell's tyres an ounce of rubber on the tread requires a force of 10 lb to hold it in position, but at 500 miles an hour (the speed at which the tyres were tested on Dunlop's special machine) the same piece of rubber requires a force of 500 lb to hold it in position.

To return to normal racing car tyres, cotton was used in the construction of the casing for a great number of years, until the introduction of Nylon. Experiments were made with this material, and in fact it has now been used in the construction of tyre cases for several years. From the viewpoint of light weight, road holding and security at high speed it has proved most commendable. The extra security is gained from two factors: cooler running, and increased resistance to heat generated.

While the introduction of Nylon into the casing of tyres probably assisted their development more than any other single factor, tread patterns have also undergone considerable development in the last few years. Fig. 1 shows four different tread patterns. The first, on the extreme left, is the Dunlop R1 tyre. This originally appeared in 1948 and was used for very nearly 10 years of racing. During this time, however, the R3 was introduced, which is the next tyre to the right, and it was found that this tread was very effective in giving better road holding on dry surfaces. Later came the Dunlop R4, the third tyre from the left, which represented a completely new approach to tread pattern design for racing cars. As can be seen there are a great number of wiping edges provided in this tyre giving maximum grip on wet surfaces.

The last tyre seen on the extreme right is the Dunlop R5. It embodies what may be described as Y-type channels. The stem of the Y lies across the tread, this being the part of the pattern that gives gripping power during acceleration and braking. The V's in this formation are interlocked and reversed to form a series of grooves which improve grip and stability in cornering. This was the tyre, referred to earlier in this article, that gave the Lister Jaguars a 5 per cent improvement in lap times at Silverstone. It was found to be equally effective in the dry and the wet, and better than any of the previous designs in both these conditions.

RIPPLE OR STANDING WAVE

Fig. 2 shows a conventional road tyre under special circumstances. The tyre is first on the high-speed drum at the Dunlop factory showing the effect of what is known as high-speed "ripple," which is a phenomenon that occurs at speeds of well over 100 miles an hour. Next, is a photograph of the same tyre photographed in exactly the same position but this time fitted to a car travelling at over 100 miles an hour on a racing circuit. It is obviously necessary with a new high-speed design to establish precisely the speed at which ripple begins, and to make sure that this speed is greater than the maximum speed of the car.

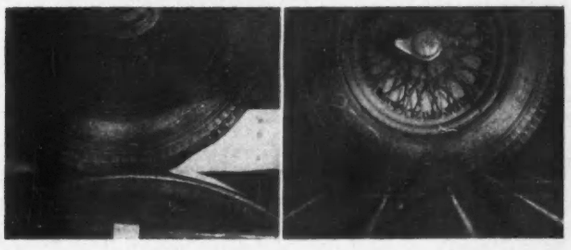


Fig. 2 (left) On a Dunlop test drum, showing the effect of high speed ripple; (right) the same tyre at over 100 m.p.h. on a racing circuit.

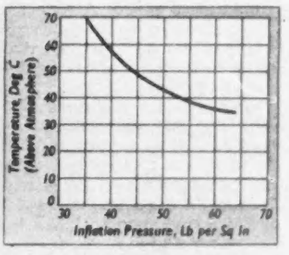


Fig. 3 Effect of inflation pressure on tyre temperature.

Considerable overheating can occur when rubber is deflected excessively, either through ripple or under-inflation, and practically all tyre failures are due to overheating. When a tyre overheats the rubber compounds soften and lose their physical properties, and under the centrifugal force to which the tyre is subject any softening will cause the tread to fly off and can lead to weakening of the ply adhesion and disintegration of the covers. Lastly it is interesting to study the graph in Fig. 3, which shows the effect that inflation pressures have on tyre temperatures. The importance of pressure was borne out by the experience of our team; for example reducing or increasing tyre pressures by 2 or 3 lb per sq. in made a second or two difference on lap times.

On the Shelf

By Frank H. Smith

THE advisability of microfilming every journal that is produced as it reaches the bound volume stage was borne in on me recently. A much-used volume of a journal in my library was lent to another department for a typist to copy something. She knocked the volume off the desk and the weakened binding went for a Burton. Where the binding tapes were fixed the index suffered and about 20 items were as good as illegible. The volume had to be rebound, of course, and I thought the best way over the index difficulty was to get a Photostat of the publishers' copy and bind that in. Sorry, said the publisher, but our copy has been used so much that it won't be worthwhile copying! Of course, there are copies in the country that will not be so well-thumbed but it does show that a position could arise where not a solitary index was available. Not that a microfilm's all that good, but it's better than nothing.

I believe the Tack Organisation is the last word in salesman trainmanship. Rank Precision Industries (37-41 Mortimer Street, London, W1) is handling a film called "Professional Selling" in which Tack had a hand, and though I've not had Tack training I can try to sell it to you at £60 a touch or hire it to you and up to 39 others at £4. Another film from the same source (Rank) at £5 a hire is "How to Handle Your Boss." No comment, except that it might be just the thing for the Typists' Pool Christmas "do." Actually I don't think it is that sort of relationship. Probably just another lesson for the shop steward.

Some fellow-traveller at 36 Bedford Street has kindly translated for me a booklet entitled "International Geophysical Year: Bibliography of Literature in Russian" which has come from (I hope) the USSR Academy of Sciences. Moscow seems to be sufficient address for all these bodies who, I suspect, is (are?) one man in an attic in the Kremlin. A pretty compliment is paid to us (or the Americans) by inserting an English index after the native one at the end.

It was not so long ago that titanium burst upon us as the wonder metal of the fifties (or was it the forties?) and its application to the aircraft industry was especially looked forward to (if one may end a sentence thus). In May, 1960, I.C.I. Titanium Plant, Waunarlwydd (which sounds like a combination of African veldt and Welsh hills) held a symposium on "Titanium Production Methods in the Aircraft Industry" and if you care to try your luck for a copy of the papers, address it to Mr. H. W. Shaw of I.C.I. Metals Division, P.O. Box. 216, Kynoch Works, Witton, Birmingham 6.

Some people do make things difficult. I suppose some poor devil of a librarian will be asked to produce the Melbourne Conference on Solid State Physics, August, 1959. He'll promptly pass the buck to the most likely source until finally somebody will know (but who?) that the papers were issued as No. 2A of Vol. 13 (July, 1960) of the *Australian Journal of Physics*. But you can't file it separately under your conferences (or wherever you put the thing) because its pagination is included in the volume. The French are fond of doing that sort of thing. (And don't tell me Melbourne is not in France. I know.)

My goodness, the old penny-in-the-slot machine has come a long way. Coincident with the Dairy Show, the Vendoo Division of Joseph Sankey Limited (Wellington, Shropshire) brought out a newspaper type affair called *Vending Express*. The accent seems to be on milk dispensers. Remember the war-time story of the evacuee who thought that all milk came from tins until he saw a real cow? If these vendors spread there will be a generation growing up that will never have any idea of the udder kind of milk.

Railway Workshop Practice—To Scale

Manual of Model Steam Locomotive Construction. By MARTIN EVANS. *Percival Marshall.* (30*s*)

The locomotive has always been a favourite subject for model makers, whose ranks have grown many times over in the last half-century. This increase has been primarily due to the performance of the modern model being both predictable and satisfactory, features resulting from the adoption of coal firing—as distinct from spirit burning—and from the design being in balance. For most of the period mentioned followers of the hobby have been well catered for, so far as drawings, tools, materials, and fittings have been concerned. Anyone in any doubt upon these points has but to visit some of the larger model engineering exhibitions. In view of this great interest it is peculiar that very few books on model steam locomotive construction have appeared, though articles have been published in profusion. On reflection it will be realised that the lot of the author of such a book is not an easy one, for it is necessary to deal with the involved subjects of locomotive design and workshop techniques in a way readily understood by readers who in most instances are not engineers.

The author of the work under review is well qualified by experience to write such a book, the scope of which varies from choice of gauge and scale to working the finished engine. It is well written, well indexed, and adequately illustrated; the photographs are excellently reproduced. Everything the average model locomotive engineer would require to know for the construction of locomotives up to 5 in gauge is covered, and additionally much information on the larger gauges and full-size practice is included.

It is appreciated that considerations of space preclude treating all the facets of model locomotive building in all sizes but it is hoped that in future editions the chapter on boiler making will be enlarged.

There is a tendency for the scale of models to increase in size, and today many more of 1½ in scale are constructed than was formerly the case. While this book contains information on engines up to 10¼ in gauge riveted construction of boilers is not discussed, and very little has appeared elsewhere on the design and construction of boilers of these larger sizes. Brazing alone is very satisfactory in the smaller scales but an attempt to insure a 1½ in scale boiler so constructed has been known to be turned down offhand.

The book will be kept at many a locomotive builder's elbow for, apart from its general interest, it contains most of the answers to the questions which arise.

C. R. H. SIMPSON

A Faith Compatible

Religion in a Space Age. By JOHN LAMBLEY. *George Roland.* (10*s*)

The inadequacy of superficial belief and the need for a sure faith were probably never more acutely felt than at this present day. A man's life is built on his faith. To be valid it must be objectively based—no mere superstition.

Mr. Lambley is conscious of this need and of the classical problem of a "nature red in tooth and claw." He remarks (unnecessarily) that he is neither theologian nor scientist. He is, in fact, in his own words "the man in the street" and it is from this fact that the book gains its value. It is a sincere, sometimes intelligent and almost wholly uninformed piece of deistic philosophy, which carries the author at times dangerously near to Fascism, with his denial of human equality and his emphasis on man's obligation to assist Evolution. Yet with all this it is a surprisingly accurate reflection of the kind of thinking of many today, whose knowledge of both science and religion is due to hearsay, and whose opinions owe nothing to scholarship, either their own or that of others. Thus it is one thing to have sincere doubts about the bodily resurrection of Christ. It is quite another matter to suggest that St. Paul and the Evangelists never intended their accounts to be taken literally.

Those who are looking for an authoritative account of the impact of the space age on religion will be disappointed, but the book should be read by those who with this reviewer see in the Phenomenon of Christ the only adequate basis for faith and the means by which "the man in the street" may discover what God is like.

R. L. F. BOYD

Freezing Cybernetics

Refrigeration Controls. By HAROLD H. EGGINTON. Refrigeration Manual No. 3. *Refrigeration Press Limited.* (15*s*)

Refrigeration Controls is the third book in a series of refrigeration manuals by Mr. H. H. Egginton. The series is intended as an introduction to the theory and practice of refrigeration. The first two books deal with the fundamental thermodynamics of refrigeration. In this third book the author discusses the characteristics, limitations, use and misuse of the various automatic valves and switches which control the vapour compression type of refrigerator.

The vapour compression refrigerator is by far the most popular. Refrigerant is evaporated and superheated at low pressure and temperature, and condensed at high pressure and temperature, usually by circulating cooling water or air. The vapour is pumped from the evaporator to the condenser by a compressor. The flow of liquid from the condenser to the evaporator must be carefully controlled by the expansion valve. An excess could allow liquid to enter and ruin the compressor; a deficiency results in a high degree of superheat and thus uneconomic operation.

Two types of expansion valve are considered. The first maintains constant pressure in the evaporator, an excess of liquid being prevented by switching off the compressor when the degree of superheat becomes dangerously low. The thermostatic expansion valve maintains a small degree of superheat, and hence high efficiency, under normal operating conditions; though special types keep it higher during the initial pull-down, reducing the load on the compressor.

The thermostatic expansion valve is considered in great detail, deservedly so, since it is the most common kind. However, it is unsuitable for very low temperature work, the usual method being to maintain a constant level in a flooded evaporator. This method of control is not considered.

A chapter is devoted to valves which vary the cooling water flow to obtain more economic operation. Valves are inserted between the evaporator and compressor for two reasons. The suction pressure regulator protects the compressor from overload by reducing the pressure to some safe value during pull-down. The evaporator pressure regulator maintains the pressure and temperature of the evaporator when the demand on the refrigerator is reduced. It is employed for fine capacity control when

on/off switching of the compressor motor would be too coarse. These two valves are of large capacity, and are usually servo driven from smaller pilot valves. A chapter is devoted to servo valves. The author, also discusses the solenoid valve and its use for shutting off refrigerant flow.

There is no doubt that Mr. Egginton is familiar with many aspects of refrigeration control, and the book contains a great deal of useful information for those unfamiliar with the subject. But the unsystematic presentation, which makes it difficult to classify the features of each control, will confuse many beginners. The lack of an index aggravates this situation.

A glaring example is the chapter headed "Pressure Operated Types: Suction Pressure and Evaporator Pressure Regulators." After distinguishing between the two types the chapter deals solely with the former. The following chapter's title is "Pressure Operated Types: Evaporator Pressure Regulators." The electrical solenoid shut-off valve and the pressure switch, used to control the compressor, are treated in the same chapter.

Mr. Egginton writes with authority but forgets that beginners should be introduced slowly to new concepts. It was disappointing not to find a bibliography. Many beginners will find this book difficult to read, but there is no doubt that nearly all the relevant facts are included.

GERALD L. FITTON

Organising Facts and Putting Them Over

Technical Communication. By GEORGE C. HARWELL. *The Macmillan Company, New York and London.* (26*s*)

Survey of Information/Library Units in Industrial and Commercial Organizations. Compiled by D. J. CAMPBELL, and edited by C. W. HANSON. *Aslib, 3 Belgrave Square, London, SW1.* (12*s* 6*d*, members 10*s*)

Technical Communication deserves a place in any library for, although admittedly intended primarily as a textbook for the engineer, it is also of considerable general interest. It claims to show what good writing really is, stresses underlying principles and is backed with a large number of actual examples. Each of its ten chapters concludes with exercises of varying levels, while a 62 page so-called "Manual of General Composition" should serve as a valuable refresher to many in its reminders of grammatical inaccuracies, punctuation rules, the effectiveness of rhetoric and the importance of correct spelling. A whole chapter is devoted to business letters and the modern tendency to streamline correspondence. Three chapters deal at considerable length with the writing of reports.

The chapter on the preparation of technical articles is particularly interesting. It emphasises that it can not only be a very satisfying experience but that it is a means of adding to one's knowledge, because of the research and the thorough assimilation of data which must precede accurate writing. It differentiates between the levels of the three general types of technical magazine: professional journals, trade magazines and house organs and gives examples of the general structure recommended.

Some 22 pages are devoted to effective speaking under the title of "Oral Communication." Some simple rules are given, these being followed by a description of the advantages and disadvantages of using visual aids. Although this chapter is useful, participation in a speech training course would in my opinion be more likely to pay dividends than the mere perusal of this chapter.

Finally, tables, graphs and drawings are the subject of a whole chapter, which claims that they often show what words cannot describe quickly and accurately and that they also help on occasions to make descriptions and comparisons vivid. The volume carries an index but no bibliography.

The *Survey of Information/Library Units in Industrial and Commercial Organizations*, published by Aslib, is a very interesting 42 page report but with the accent on library practice rather than information services, in that only four and a half pages out of 42 are devoted to information work. In most cases the data relate to 1955 to 1956. As there has been a considerable growth of interest lately in information/library services for industry, the picture may have changed in the meantime.

The survey discloses that more engineering organisations possess information/library units than any other industry, the chemical and allied industries being a fairly close second, while the third in order of importance is the transport vehicle industry.

It is interesting to note that in 32 out of the 52 organisations forming the sample, the information/library unit is responsible to a senior technical officer of ranging status, the remainder being responsible to administrative heads of one kind or another. Among the heads of units 58 per cent are either graduates or chartered librarians or both. Among the supporting staff there were three women to one man. About three times as much is spent on salaries and wages as on the purchase of publications. Only half the units sampled scan national or local newspapers. About 90 per cent of the units issue some kind of serial publication, most of them monthly; nearly all compile lists of new books and selected literature references, with abstracts.

The survey is a kind of publication which does not lend itself to an index but the contents list is quite adequate for this purpose. It should prove useful both to existing information/library units, permitting comparisons to be made of organisational set-up, and also to newcomers to the information field.

GEO. H. DAVISON

Prime Mover in Suspended Animation

Introduction to the Gas Turbine. By D. G. SHEPHERD. 2nd Edition. *Constable.* (45*s*)

The gas turbine has been a contender in the field of power production long enough to be viewed in a fairly wide perspective. The first glamorous decade of its existence has been followed by what, on any reckoning, can only be called a period of suspended animation. During this time considerable progress has been made in the development of its main competitors and there is now a fierce struggle for supremacy in the various fields of application.

It is in this context that the second edition of the above book is presented. Originally published in 1949, the author claims that the text has been completely rewritten with a view to a more basic approach, in which less attention is given to detail. The book consists of eleven chapters, covering in all some 300 pages. What chiefly distinguishes it from other texts on the subject is the unified treatment given to compressors and turbines together with separate chapters on heat exchange and applications of the gas turbine. It may, however, reasonably be asked whether heat exchangers are not adequately covered elsewhere. It is also fair to comment that the chapter concerned with compressors and turbines also includes some fundamental work best described as gas dynamics.

The style is generally good, and the index and bibliography, though the latter is incomplete, are nevertheless adequate. A knowledge of elementary thermodynamics and fluid flow is presupposed, as is some familiarity with the differential and integral calculus. The presentation suffers to some extent by poor execution of the illustrations, many of which, in the reviewer's opinion, are too small.

What is not clear is to whom the book is addressed. The author refrains from any statement of his intentions in this respect, though one suspects from the academic nature of his employment that he has students chiefly in mind. In this case it is a pity that so few problems are worked in the text, especially since none are provided for the reader to solve.

If, on the other hand, it is intended for the practising engineer, then one wonders whether (*a*) it has not come rather late in the day, and (*b*) the subject is treated in sufficient depth. For instance, discussion of turbine blade cooling is limited to a few short paragraphs in a chapter of twenty-four pages. Admittedly, the author quotes a further reference but since a very great deal of research and development effort has been devoted to this topic in the period since 1949, when the first edition appeared, it might be thought to merit greater consideration if the book is really intended for the designer or specialist.

The author states that a major difficulty is to cool adequately the leading and trailing edges of the blades without sacrificing too much profile efficiency. Recent work suggests that this dilemma is not so serious, at least in the case of the trailing edge, as was originally thought. Appreciable thickening has been found to have little effect on aerodynamic performance over a fairly wide range of conditions. Such trailing edges appear capable of accommodating adequate cooling passages.

The final chapter, which reviews briefly both existing and possible future applications, is disappointing. In the desire to avoid committing himself too deeply the author has also made this important chapter rather lifeless; it is surprising that he should omit any reference to the promising diesel engine and gas turbine combinations. These are, of course, (*a*) the diesel fitted with an exhaust turbo-supercharger; (*b*) the diesel-air compressor combination in the form of a free-piston engine acting as a hot gas generator for a gas turbine; and (*c*) the supercharged diesel-gas turbine combination where both units provide useful output, the diesel exhausting at low pressure to the gas turbine. In the reviewer's opinion, the author could also have said more about projected nuclear power applications.

There are a number of instances where methods of analysis have been devised which are novel, and superior to those currently used. One such example is the discussion of three-dimensional considerations in the chapter on compressors and turbines. But when the volume is considered as a whole its advantages over other texts seem largely to be marginal, whether in respect of improved treatment of existing theory or the incorporation of new material. Perhaps this is only a reflection of the plateau of development on which the gas turbine is at present resting!

B. W. MARTIN

New Books

Engineering Education in Russia. By STEPHEN P. TIMOSHENKO. *McGraw-Hill, New York and London.* (21*s* 6*d*)

Professor Timoshenko bases his short account of the Soviet engineering education system on his personal knowledge of the pre-revolutionary period and his return visit in 1958, and briefly compares the Russian and American school curricula.

Runnerless Molding. By ERNEST P. MOSLO. *Reinhold, New York; Chapman and Hall, London.* (40*s*)

Runnerless moulding of thermoplastics first appeared in patent form 20 years ago, and its development as an essential part of automation in injection moulding is traced here by the president of a specialist company.

Symposium on Newer Metals. ASTM Special Technical Publication No. 272. *American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.* ($7·25, *members* $5·80)

The proceedings of the symposium were grouped under three headings: the first, on refractory metals, included molybdenum, tantalum, columbium and the platinum group; the second, on nuclear and light metals, covered beryllium, zirconium and yttrium; while the final group was concerned with the purification and fabrication of columbium, tantalum, molybdenum, chromium and lithium.

Garage and Service Station Handbook. Edited by JOHN QUEENBOROUGH. *George Newnes.* (42*s*)

From a survey of the motor industry for the man thinking of entering the garage business to a description of currently available service and showroom equipment, this practical reference book gives a very full coverage of the trade. Sections are included on layout, wages, stores control, accounting, salesmanship, display, private hire, law, and insurance.

Experimental Plastics. C. A. REDFARN and J. BEDFORD. 2nd Edition. *Iliffe.* (22*s* 6*d*)

In 1949 when the first edition of this practical course was published only evening class instruction in plastics technology was available. Today full-time, part-time and evening courses are offered at a number of well-equipped colleges, and practical instruction is required for the Graduateship of the Plastics Institute. Here are presented some eighty experiments in resin preparation, compounding, fabrication and testing techniques.

Directory of Opportunities for Graduates, 1961. *Cornmarket Press.* (8*s* 6*d*)

In face of an increase of 7½ per cent in the number of men and women graduating from universities in Great Britain in the past year, the number of companies and organisations giving details of their staff needs and opportunities in this directory has increased by 21 per cent, giving a total of 332 entries.

Impact: The Theory and Physical Behaviour of Colliding Solids. By WERNER GOLDSMITH. *Edward Arnold.* (90*s*)

Basing his approach on a series of lectures given at the University of California, Berkeley, Professor Goldsmith divides his subject into two parts: firstly the dynamics of the process, including plastic and vibrational aspects; and secondly the behaviour of materials under conditions of dynamic loading.

Fluid Mechanics through Worked Examples. By D. R. L. SMITH and J. HOUGHTON. *Cleaver-Hume Press.* (28*s*)

Designed to help students working for internal or external degrees, HNC, Dip. Tech., or the examinations of the Institution of Mechanical Engineers, this collection of 163 worked examples is supplemented by a further 275 problems drawn from University of London and I.Mech.E. papers.

The Report of the Marine Reduction Gear Research Committee No. 2. *Ship-Machinery Manufacturers' Association of Japan, 2 Kanda Tsukasa-cho 2-chome Chiyoda-ku, Tokyo.* ($1·50)

Since 1956 a programme of research has been conducted into the materials, design and manufacture of marine reduction gears, under the authority of the Japanese Ministry of Transportation, and organised by a committee drawn from the universities, research, and gear manufacturers.

Synthetic Rubber Technology. By W. S. PENN. Volume 1. *Maclaren and Sons.* (50*s*)

Most scientists in the rubber industry are primarily concerned with the compounding and processing of elastomers, and it is with the technology rather than the chemistry of the subject that the present volume is concerned. Sections included cover general laboratory and factory practice, and the grades, properties, compounding, processing and applications of SBR, high styrene resins, butyl rubber neoprene, nitrile rubber, silicone rubbers, and Thiokols.

Machine Drawing and Design. By W. ABBOTT. 7th Edition. *Blackie.* (21*s*)

Over the thirty years since the first edition appeared Dr. Abbott's book has been largely rewritten, and has had major additions. It provides an intermediate course for university and professional institution students.

Fundamentals of Digital Instrumentation. By D. S. EVANS. *Hilger and Watts Ltd., 98 St. Pancras Way, London, NW1.* (7*s* 6*d*)

The need for the conversion of analogue information to digital form is one which concerns an increasing number of engineers and designers. Although the present monograph is based on shaft-driven digitizers, the problems are common to other types of convertor.

Safety on the Site. By B. A. C. WHYTE. *United Trade Press.* (20*s*)

A manual of accident prevention for the building and constructional engineering industries, well illustrated, and with full reference to relevant regulations, written by the safety officer of a large construction company.

Growth in the British Economy. *Political and Economic Planning and Allen and Unwin.* (30*s*)

This report is an objective study of the performance of the British economy since the war and of the effect of government policies on economic growth. It is the result of a three year study carried out by PEP under the guidance of an advisory group which brought together representatives of public and private industry, the trade unions, and working economists.

Exercices Numériques de Mécanique en vue des Applications Industrielles. By A. TENOT. Volume 1. *Librairie Scientifique et Technique, Albert Blanchard, 9 rue de Médicis, Paris 6.* (14 *NFr*)

A reprint of the edition originally published in 1942.

The Construction of Ford Specials. By JOHN MILLS. *Batsford.* (18*s*)

For an outlay of from £100 to £600 the motoring enthusiast can build a car with performance equal to that of a production model costing three times as much. The Ford 8 or 10 is probably the ideal chassis on which to base such a "special," as not only are the mechanical components as strong as any, but also the supply of spare parts is unsurpassed by any other make.

The Landscape of Roads. By Sylvia Crowe. *Architectural Press.* (18*s* 6*d*)

During the next three years some £230 million is to be spent on roads in this country. If they are not handled with the care that characterises the best examples shown in Miss Crowe's book they will go far to ruin much of what remains of our landscape.

Reports on Progress in Physics. Volume 23, 1960. Edited by A. C. STICKLAND. *Physical Society, 1 Lowther Gardens, Prince Consort Road, London, SW7.* (63*s*, *members* 21*s*)

The ten papers in this year's issue include surveys on interference spectroscopy, optical properties of thin films, photoelectric photometry, group theory in solid state physics, and ^{3}He induced reactions.

Statistical Processes and Reliability Engineering. By DIMITRIS N. CHORAFAS. *Van Nostrand, Princeton, New Jersey and London.* (96*s*)

This study of the mathematics of reliability for the project manager and the engineer presents statistical techniques and experimentation, stochastic processes, cybernetics and information theory, statistical quality control, and reliability engineering in its strictest sense, that is to say, designing a product for reliability.

Simplified Short-Circuit Calculations. By R. T. LYTHALL. *Belmos Company Limited, Bellshill, Lanarkshire.* (5*s*)

A practical handbook showing how sufficiently accurate short-circuit values can be calculated by simple arithmetical means, for application to 400 to 600 volt group motor control and distribution switchboards.

Tables of Thermodynamic and Transport Properties of Air, Argon, Carbon Dioxide, Carbon Monoxide, Hydrogen, Nitrogen, Oxygen, and Steam. By JOSEPH HILSENRATH and others. *Pergamon Press.* (140*s*)

A reprint of the tables originally published by the US National Bureau of Standards in 1955, with minor corrections.

The Reviewers (*pages 866, 867*)

Dr. Robert L. F. Boyd, A.M.I.E.E., F.R.A.S., whose academic training has included electric power engineering and ionic physics, is reader in physics and leader of the space research group in the University of London.

Mr. C. R. H. Simpson, Assoc.I.Loco.E., is assistant to the technical sales manager of Beyer Peacock Company Limited. Author of sundry books and over 2,000 articles on locomotive practice, he has been editor of the Locomotive Railway Carriage and Wagon Review and judge in the locomotive section of the "Model Engineer" Exhibition.

Mr. G. L. Fitton is employed in the Thermodynamics Department of Vickers-Armstrongs (South Marston) Limited. He is currently engaged in developing the accelerated freeze drying process for food, and is responsible in particular for work on fully automatic control.

Mr. George H. Davison is librarian and secretary of the Research and Development Department at the United Steel Companies' Swindon Laboratories. He is a member of council of Aslib and is active in many other technical and library associations.

Dr. B. W. Martin, A.M.I.Mech.E., A.F.R.Ae.S., is Reader in Applied Thermodynamics in the Imperial College of Science and Technology, University of London.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Construction

Partitions. ROWE INDUSTRIES (KIRKBY) LTD., Kirkby Industrial Estate, Liverpool. Glass and metal movable partitions for offices, washrooms, etc. Three page illustrated folder and set of data sheets.

Excavator. NCK-RAPIER LTD., 32 Victoria Street, London, SW1. The NCK 605 excavator, crane and grab described in a 22 page brochure with illustrations of working parts.

Roller and Mixer. BABCOCK AND WILCOX LTD., 209 Euston Road, London, NW1. The Richier self-propelled vibratory roller and reversing drum concrete mixer described in two illustrated leaflets.

Fixing Inserts. PHILPLUG LTD., Chase Road, London, NW10. Inserts of cementatious asbestos for casting into artificial stone, concrete, etc., for taking screws. Leaflet.

Frame Buildings. COSELEY BUILDINGS LTD., Lanesfield, Wolverhampton. Latticed steel portal frame buildings in spans from 30 to 100 ft. Any length in increments of 2 ft 6 in. Illustrated folder gives range.

Concrete Plant. BLAW KNOX LTD., 90-94 Brompton Road, London, SW3. Examples of concrete mixing and handling plant illustrated and described in 8 page brochure.

Duct Formers. PC FLOORS LTD., 64-66 Battersea High Street, London, SW11. Ovacore re-usable formers for casting ducts in concrete. Round, oval or rectangular in shape; made of steel or plastic. Dimensions and types shown in 8 page folder.

Cable Cleats. TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. LTD., Mercury House, Theobalds Road, London, WC1. Plastic moulded Telcleats for fastening cables to walls or trays. Illustrated folder.

Ribbed Floors. PC FLOORS LTD., 64-66 Battersea High Street, London, SW11. Kaiser formers and shuttering for casting monolithic concrete floors. Lattice beam in the ribs. Method and design illustrated and explained in folder.

Standard Joinery. BOULTON AND PAUL LTD., Riverside Works, Norwich. Windows, doors, linings, and hatches outlined in illustrated folder.

Truck Mixer. RANSOMES AND RAPIER LTD., Waterside Works, Ipswich. Truck mounted horizontal drum concrete mixers and agitators illustrated and described in 8 page brochure.

Pulling and Lifting. TIRFOR LTD., 33 St. George's Drive, London, SW1. Lever-operated pulling and lifting machines for loads up to 5 tons. Particulars and examples of application given in booklet.

Marketing

US Trade Centre in London Next Spring

THE United States Departments of Commerce and Agriculture will open the first US Government supported overseas trade centre in London next spring. The two Departments will be cooperating with the United States London embassy in sales promotion and the display of American products.

The exact location, presumably in the West End, has not yet been made known.

Two developments affecting Anglo-American trade have combined to bring about the project. The ending by the British Government of the great majority of import restrictions on US produced goods has led to a considerable rise in the volume of American goods flowing to this country and to a widening of the fields in which opportunities exist. From the United States side, the export expansion programme announced by President Eisenhower as long ago as last March is being expressed in a number of positive steps, of which this is one.

Exhibition policy at the US London sales centre is to be based on a series of themes, setting out to emphasise the types of US product with the best market prospects in the United Kingdom. Technical and commercial publications and trade catalogues will be available at the centre.

Increasing Foreign Earnings from Aircraft Engines

Discounting royalties from overseas manufacturing agreements and the value of British aero-engines fitted in aircraft for export from the United Kingdom, the value of aero-engine and spare part exports in the first ten months of the year reached £61 million.

This is at the rate of £73 million in a full year, a substantial increase on 1959's figure for the whole year's export record of £64·5 million.

Export earnings from aero-engines and spare parts since the war now amount to £343 million and two-thirds of this impressive total has been gathered in during the last four years.

On the airframe side, orders in October and November for ten British airliners were worth £10 million. These agreements brought the number of British aircraft sold to overseas customers up to the end of November up to 118. Their total value is around £114 million.

Rootes Group Going it Alone

Undeterred by the fact that the 25 rebuttals by the FORD MOTOR Company may have given the take-over bid denial something of a double meaning, Lord Rootes, the ROOTES MOTORS chairman, sailed in after the recent Rootes annual meeting and declared: "We are not interested in any sort of merger at all. We have complete confidence in ourselves."

On the future for British car exports to the United States Lord Rootes was determinedly optimistic. On grounds of quality he believes there is a permanent place in the US market for the United Kingdom's firms.

Reiterating his fellow car company chairmen, Lord Rootes underlined the industry's need for greater home sales. Some puzzlement was caused by his remarks that he was being badgered for deliveries in Britain. Apparently this squares with short-time working if allowances are made for "an adjustment in production."

The Scottish development at Linwood will cost £23 million, which is not expected to involve Rootes in raising capital outside the company.

Airport Fee Increase Puts up Home Fares

The effect on BRITISH EUROPEAN AIRWAYS of the increase by the Ministry of Aviation in landing fees at state run airfields will be to raise costs by some £430,000 a year—and to lift internal tourist class fares by 3½ per cent.

The fare increase will take place next April, at the same time that the landing fees are raised. The Corporation is not having to raise its fares on international routes, or on the Channel Islands and Isle of Man services, where no airfield increases are being imposed.

British airfield landing costs are already high by European standards. These vary from, for example, £5 12*s* 6*d* in Spain to £13 17*s* at an Austrian airport. Landing fees for a Viscount 701 at a British airfield are now about £16, after the increase it will be about £20. When the new rates are in force the landing fee in the United Kingdom of a Viscount 701 will have been just over doubled since 1956.

The extra charges will fall particularly heavily on the short distance, unprofitable Scottish island services of BEA, which are run only for social reasons.

Hovercraft Potentials in Australia

Australia, with its wide areas of flat or undulating land, has from the early days of the Hovercraft offered strong chances of useful application for the air-riding craft of the future.

Now Mr. D. Hennessey, the chairman of HOVERCRAFT DEVELOPMENT Limited, the Hovercraft company formed by the National Research Development Corporation, is visiting Australia to discuss types best suited to the needs of the transport industries. The tour will take Mr. Hennessey to Sydney, Adelaide and Melbourne as well as Canberra.

A feature of the Australian cattle business is the long overland haul of the stock from their grazing grounds to to the coastal cities. Conventional methods have been developed over the years to speed this up but as long as a year ago an Australian businessman visiting London told ENGINEERING that the use of Hovercraft of suitable size could sharply cut the time in which the cattle were carried to the coast, saving both in loss of condition and in any suffering to which they may now be subjected.

Hovercraft Development have received many inquiries from Australia. A particular application that is arousing interest is as a harbour ferry.

The British Hovercraft industry is at present made up of the NRDC's firm and four other companies who have taken out licences from HD and are pursuing various lines of advance.

HAWKER SIDDELEY, through their subsidiary FOLLAND AIRCRAFT, are working on a series of commercial vehicles to be known as Hovertrucks. The first—GERM, ground effect research machine—is being tested in Hampshire.

The Dumbarton shipbuilders, WILLIAM DENNY, are constructing a test craft and have plans to produce a Hovercraft weighing around 200 tons.

VICKERS - ARMSTRONGS, at South Marston, near Swindon, are at work on a five ton version and also on a 25 ton car and passenger ferry.

WESTLAND AIRCRAFT, a part now of SAUNDERS-ROE, who built the first SR N1, are working on SR N2, which will weight 25 tons and be available for trials in the New Year. The SR N2 will be capable of carrying 68 passengers at speeds up to 70 knots.

In the Isle of Wight, at Bembridge, BRITTEN-NORMAN have developed a one-ton prototype of their own Cushioncraft in which the banana interests see a way of transporting the fruit from plantations.

Key Court Case for US Electric Market

Important decisions affecting the future of the United States market for electrical equipment are expected to flow from the case before the Philadelphia Federal Court, where 19 major American electrical manufacturers have pleaded guilty to charges of price-fixing in contravention of the Government's anti-trust laws.

One of the defendants has entered a plea of not guilty. Counsel for those who have pleaded guilty have stated that they are not admitting all the counts on which they are arraigned but they do not want to prolong what could be a very expensive legal process.

Sales worth about £717 million a year, principally to Government organisations and to industry, are involved.

The General Electric Company of American, answering 19 indictments, pleaded guilty to six, Westinghouse Electric, named in 20, pleaded guilty to seven.

India to Buy Russian Aircraft

The visit of the Indian official negotiating team which talked with Russian aviation industry chiefs in Moscow last month has borne fruit.

The Indian Deputy Defence Minister has now confirmed that Soviet aircraft are to be purchased by the Indian Government. What aircraft and in what sort of number the Indian authorities are not disclosing "in the public interest."

Standards Shut Down Mulliners Body Works

Only two years after being brought into the STANDARD-TRIUMPH INTERNATIONAL Company, the Birmingham car body works MULLINERS Limited has been closed down.

In order to make the most efficient possible use of the company's production facilities, Standard-Triumph, themselves the subject of a take-over bid by LEYLAND MOTORS, the prosperous commercial vehicle manufacturers, are moving the work being done by the 800 workers at Mulliners to other Standard factories in the Midlands.

Shortage of work had recently compelled Mulliners to dismiss about 750 of their workpeople.

An Anniversary Down Under in General Electric

While the GENERAL ELECTRIC Company have been announcing with ENGLISH ELECTRIC in London that their merger talks have been broken off, a steadily expanding section of the GEC concern, the Australian subsidiary, the BRITISH GENERAL ELECTRIC COMPANY PTY, has been celebrating its fiftieth anniversary.

Set up in Sydney in 1910, the subsidiary now has 1,500 people in its two New South Wales factories and in its branches throughout the Dominion. GEC at home has some 70,000 employees, and assets put at about £84 million.

The Australian company began local manufacture only in 1939. It now has over 175,000 sq. ft of factory space.

Navigational Equipment for Transport Command

The Ministry of Aviation has chosen for navigation and direction finding equipment for RAF Transport Command's new Argosy C1 aircraft the MARCONI WIRELESS TELEGRAPH Company's Doppler Navigator Type AD2300B and Automatic Direction Finder Type AD712.

Including ancillary equipment and spares the orders are worth just over £650,000. The Doppler Navigator informs the pilot of the aircraft's degree of accuracy, or otherwise, in following the selected track and also gives the distance to go to the turning point. In addition the equipment feeds into the flight system or the auto-pilot information which enables the selected track to be followed.

On the automatic direction finder frequency selection is by switch and no tuning is involved.

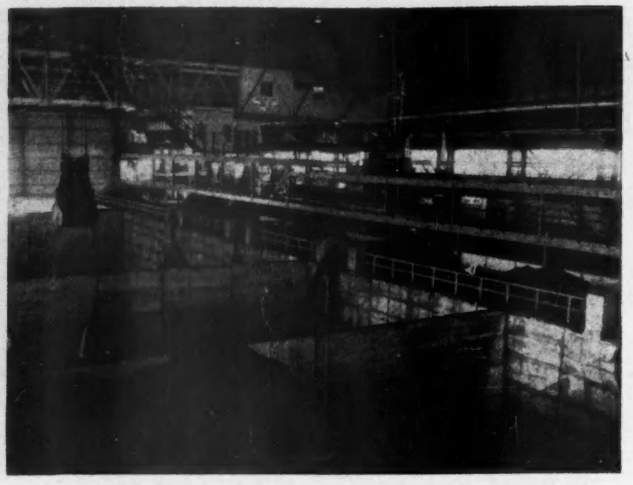
£A200,000 Contract for Purifier Boxes

WHESSOE Limited are to design, supply and erect a set of mild steel purifier boxes with a capacity of 10 million cu. ft a day for the West Melbourne Gasworks under a £A200,000 contract placed by the GAS AND FUEL CORPORATION, of Victoria.

Five boxes are to be provided. The plant will be complete with all ancillary gear, including the means of charging and discharging the oxide, and power operated valves to give automatic rapid rotation.

Engineering design and drawing is to be carried out at Whessoe's Darlington office. The contract as a whole is being organised with NORMAN J. HURLL (VICTORIA) Pty, of Melbourne, who are associated with Whessoe for work in Australia and New Zealand.

The discharge end of the sintering machine, showing the ignition hood in the background.



Inside the stockyard building, showing the storage bays, overhead crane and conveyors.

Sinter Brings Down Coke Consumption

The opening of a sinter plant which produces more and better sinter has enabled a steel company to reduce its blast furnace coke consumption.

A NEW single strand continuous sinter plant has just been opened at the Workington Iron and Steel Company by Crown Prince Harald of Norway. The £2½ million plant is designed to produce 12,500 tons of self-fluxing sinter per week and is now in full operation. The code name FOCUS has been given to the project—this stands for "Foreign Ore Concentrates Usage."

Sintering was originally adopted at Workington in 1943, and the plant which was used then was subsequently expanded to produce about 6,000 tons of sinter per week. It has successfully demonstrated the advantages of the use of sinter in blast furnace performance but it would have been uneconomic to modify it in order to produce the additional quantities of sinter of improved quality which are needed at the Workington blast furnaces. The decision was therefore taken to build the new plant.

Post-war developments in Norway have made available considerable quantities of iron ore particularly well suited to the Acid Bessemer steel making process employed at Workington. The ore is mined in open cast workings by the Sydvaranger Company at Kirkenes, in the north of Norway. After processing, the ore is shipped in the form of a powdered concentrate containing 65 per cent iron. As well as possessing a high iron content, the concentrate is low in phosphorus and other impurities.

INPUT

The Acid Bessemer process of steel making employs converters lined with silica bricks. Silica is chemically an acid material, and with a lining of this kind it is not possible to remove any phosphorus from the iron during its conversion to steel. It is therefore essential to start with a raw material which is both high in iron and low in phosphorus and other impurities—hence the attraction of the Norwegian concentrates.

It is intended that between 60 and 70 per cent of the incoming raw materials to the plant should come from this Norwegian source. This is equivalent to an annual intake of 400,000 tons. The balance will be provided from other overseas sources and from the company's own hematite ore mines in Cumberland, which are currently producing about 120,000 tons a year.

The bulk of the company's ore requirements arrive by sea at the nearby Workington Harbour and Dock. This 1,000 ft long dock can accommodate vessels up to 10,000 tons and is equipped with eight powerful cranes for the rapid discharge of ore and the loading of finished steel products.

From the dock, imported ore is conveyed by rail wagons to a material storage building. In the stock bays there, there is capacity for 44,000 tons of ore fines. The building is divided into five separate bays with the following capacities: Sydvaranger concentrates, 16,500 tons; hard ore fines, 11,500 tons; soft ore fines, 9,000 tons; home ore fines, 7,000 tons; and coke breeze, 350 tons.

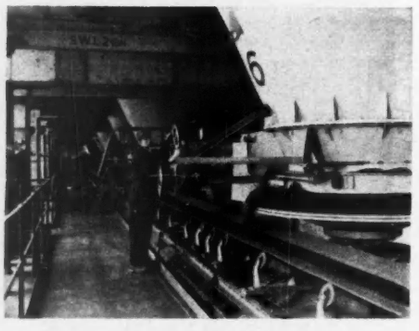
MIXING

Sinter mixture materials are fed on to a gathering belt by 9 ft diameter rotary feeder tables fitted with speed adjustment. In addition the coke feeders have independent speed control. After primary mixing in a twin paddle rotary drum mixer of 200 tons per hour capacity, the mix is conveyed onwards to a surge hopper from which it is fed under control to a pelletising drum. In this drum, the final mixing and adjustment of water content is made. Pelletising increases the permeability of the sinter bed on the strand and permits a faster sintering rate. To avoid degradation of the fragile pellets, a vibrating feeder is installed to transfer the mix from the pelletising drum to the sinter strand.

The Head Wrightson/McKee single strand continuous sintering machine is 6 ft wide and 180 ft long. It is equipped with 28 wind boxes and has an effective grate area of 1,008 sq. ft. Strand speed is variable between 45 and 170 in per minute, the mix being ignited by an automatically regulated mixture of blast furnace and coke oven gases with combustion air. The ignition furnace or hood is 6 ft 2 in long by 7 ft 8 in wide and operates normally on a blast furnace/coke oven gas ratio of 7 to 1. The design nevertheless caters for operation on either 100 per cent blast furnace gas or 100 per cent coke oven gas. The air blower has a designed capacity of 2,500 cu. ft per minute at 12 in w.g.

Gas from the wind boxes is collected in a straight dust collector wind main of increasing cross-sectional area, the last 90 ft long section of which acts as a dust settling chamber.

Discharged sinter passes through a breaker with 6 in knife spacings to a Schenk vibrating screen. By means of a variable speed feeder, the oversize sinter is fed to a Lurgi-Frodingham circular cooler with a designed capacity of 100 tons per hour, the temperature of the sinter being reduced from 850° C to 100° C during its passage through the cooler. Pallets in the cooler discharge the sinter into a hopper for transfer via a variable speed feeder and a conveyor to a further screen at which the sinter may be separated into two size ranges before delivery by transfer car to the furnace bunkers.



The raw feed gathering belt, showing the storage bins. The operator is adjusting the ore feed.

The hot undersize sinter is carried by a tray conveyor from the sinter screen to a quenching station. Here, a Schenk screen mounted over twin 50 ton capacity bunkers divides the returns into two size fractions, $+\frac{3}{8}$ in for bedding material and $-\frac{3}{8}$ in for use as return sinter. After cooling, the bedding fraction passes to a 55 ton capacity surge hopper with a rotary feeder table from which it is fed back to the sintering strand. The return sinter fraction ($-\frac{3}{8}$ in) is transferred to the return fines storage bins in the material storage building.

EFFICIENCY

Four Buell dust extraction systems are employed to collect the dust arising at various points in the plant and to discharge it finally into the primary mixing mill. These systems serve the conveyor lines in the material storage building; the discharge end of the sinter machine and sinter cooler area; the quenching station area; and the high line screening station area.

From the initial commissioning stage, output from the new sinter plant is being brought up gradually to its rated capacity. Early indications are that the beneficial effects anticipated on blast furnace operations will be more than fully realised as, even in the present intermediate state, a reduction in the blast furnace coke consumption has been made possible following the use of this sinter.

Measuring Roughness in Electric Motors

An instrument has been developed which measures separately both bearing roughness and out-of-balance in electric motors. This represents an advance over previous methods which depended upon the senses of touch and hearing.

By A. S. Ennis and R. S. Jackson, B.Sc., A.M.I.E.E.

Research Department, AEI (Manchester) Limited

IN THE manufacture of electric motors fitted with rolling bearings, the condition of the bearings is usually assessed subjectively using the tactile and, to a lesser extent, the aural senses. The bearing condition is referred to in terms of " roughness " and, with experience, good indication of the conditions can be provided by the human senses. As with other subjective estimates, however, judgments are liable to variation between different observers and are often subject to question, particularly in borderline cases, where rejection or acceptance of a machine may depend upon the result. The need for an objective meter to replace or augment personal judgments is apparent and the development of an instrument which correlates well with subjective estimates is described in this article.

Since the assessment of inspectors is likely to remain the final arbiter, one of the first essentials of any meter designed for bearing roughness measurement must be that the indications are in agreement with critical subjective impressions. From early experimental work carried out with simplified apparatus, it has been established that bearing vibrations measured in terms of velocity give good general agreement with subjective estimates. In addition, it has also been shown that a high degree of discrimination is subjectively possible between the vibration due to bearing roughness and that due to rotor out-of-balance forces. The bearing roughness vibration usually consists of a number of components not harmonically related and covering a wide frequency range, while the out-of-balance vibration approaches sinusoidal motion in the frequency range of 10 to 60 c/s depending upon speed.

Another important source of vibration in electric motors, that due to magnetic causes, can for the purpose of bearing tests be reduced to negligible proportions by applying only sufficient voltage to the machine to enable normal rotor speed to be maintained. The bearing roughness and out-of-balance vibration are always present in varying degrees and are summed together in conventional vibration meters so that a true roughness measurement may not always be obtained.

To be successful, therefore, a roughness meter must be capable of discriminating between vibration due to rotor unbalance and that due to the ball and roller bearings. These requirements entail the use of filter circuits to isolate the out-of-balance component and when this is done, it becomes possible to arrange that the meter measures the two quantities separately. In the meter to be described, the bearing roughness is measured on a velocity basis as this is closely related to hearing and feeling while the fundamental component of rotational unbalance is given in terms of displacement as this conforms with normal engineering practice.

INSTRUMENT DESIGN

Since the primary measurement required is bearing roughness in terms of velocity, it was convenient to use a vibration detector responsive to this characteristic. A Philips PR9260 moving coil unit was chosen because these instruments have a relatively high output signal for a given vibration and are reasonably robust for use in a works test department. The out-of-balance frequency range to be covered, 10 to 60 c/s corresponding to rotor speeds of 600 to 3,600 r.p.m., could best be met by using an instrument with variable tuning. After considering a number of possibilities, a Dawe 1401DX audio frequency analyser was chosen and the circuit modified to that shown in Fig. 1.

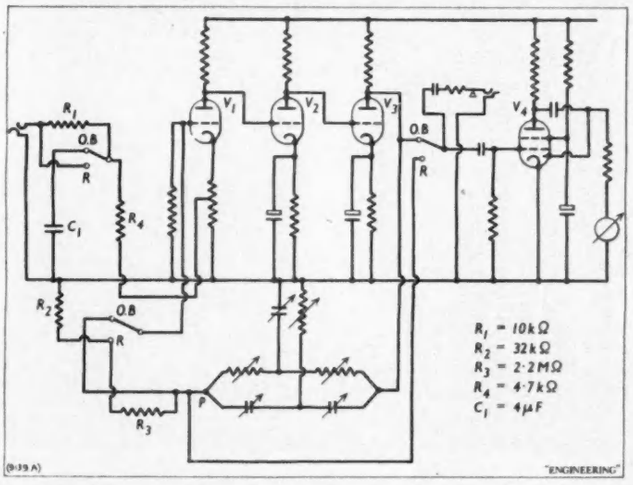


Fig. 1 (left) The modified audio frequency analyser circuit used in the instrument.

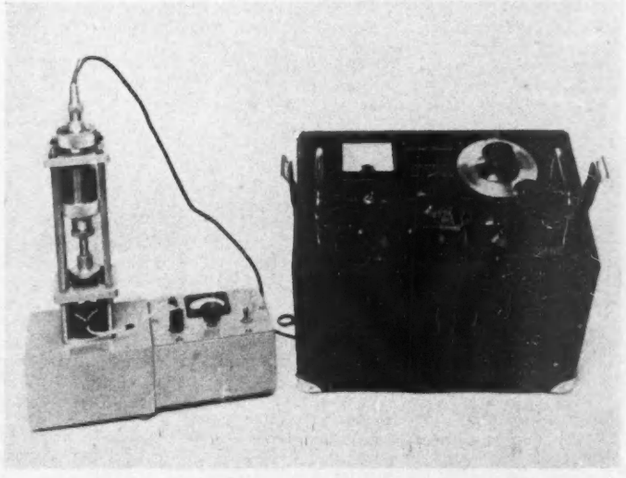


Fig. 2 (right) The complete equipment which measures bearing roughness and out-of-balance.

The basic circuit of the instrument consisted of a three-stage d.c. amplifier V_1, V_2, V_3, the output terminal of which was connected to the grid V_1 through a parallel-T network. At the null frequency of the network no feedback occurred and the amplifier had its full gain, but at frequencies other than this value, a fraction of the output voltage was applied to the input, giving the overall frequency response its selective character.

With the selector switch set to the " out-of-balance " (OB) position, the instrument behaved as a conventional feedback analyser, adjustment of the frequency controls enabling a machine's out-of-balance vibration to be determined in the usual way. To allow these measurements to be made in terms of oscillatory displacement, however, it was necessary to include in the OB setting an integrator R_1, C_1 in the input circuit and the values of these components, 10 kΩ and 4μF respectively, ensured that for out-of-balance frequencies above 10 c/s the instrument measured oscillatory displacement directly.

In the " roughness " (R) position, the voltage necessary to supply the meter circuit was obtained from the null terminal P of the parallel-T network. Under these conditions, the instrument accepted all components differing in frequency from the in-tune value, which was rejected, and thus fulfilled the requirement of removing the out-of-balance signal from the output while still leaving the remaining bearing roughness components.

CALIBRATION

The overall sensitivity and selectivity were adjusted to convenient values by reducing the feedback using resistors R_2 and R_3 and since for the roughness measurements the instrument was required to be velocity sensitive, the integrator was omitted in the R setting.

Initial overall calibration of the equipment is based upon laboratory standards. However, to enable the sensitivity to be checked under test bed conditions, a small moving coil vibrating table has been developed, which for a fixed electrical input from the 50 c/s mains gives a known oscillatory displacement.

APPLICATION

Practical use on an electric motor test bed over a period of several months has enabled the behaviour of the instrument to be compared with subjective estimates of bearing roughness and good agreement has been established. Consequently, it is expected that meter values of bearing roughness will soon be available which can be used as a reliable guide to bearing conditions. The ability of the instrument to determine out-of-balance vibrations in addition to bearing roughness has also proved to be of considerable value.

Acknowledgement.—The authors wish to thank Sir Willis Jackson, Director of Research and Education, for permission to publish this article.

Improved Research for London Transport

Research to improve reliability, economy and safety is essential to a large public transport concern. A new laboratory, with excellent engineering research facilities, has now been opened by London Transport.

LONDON Transport's new research laboratory at Chiswick was officially inaugurated recently by the Chairman, Mr. A. B. B. Valentine. It has enabled the scientific staff of the research department to be brought together under one roof for the first time and it will be the centre for the scientific control and investigation of materials and equipment used throughout London Transport's road and rail services. It also gives space for important new facilities and equipment as well as additional staff.

The facilities include a cold chamber for low-temperature testing of materials, a specially-designed screened room for radiographic work, heat-treatment furnaces and welding equipment, a pilot plant laboratory, special recording equipment for strain gauge tests, and a fatigue testing machine for railway car axles.

London Transport spends more than £15 million a year on stores and materials and an important part of the work of the small but highly specialised research department is to carry out regular routine investigations of these supplies. It is also responsible for the technical control of certain works processes.

LARGE ECONOMIES

As its name implies, the department carries out special research work of great value. Among the consequences of these investigations in the last few years have been a saving of £300,000 a year in diesel fuel for buses arising from experiments in the use of a thinner grade of lubricating oil, a further saving of £80,000 a year from improved types of rear axle oil for buses, and £50,000 a year saved by work which has led to the doubling of the life of bus batteries. Paint investigations have made it possible to lengthen the repainting period for buses to once in four years, enabling the number of "spare" buses to be reduced and painting costs decreased.

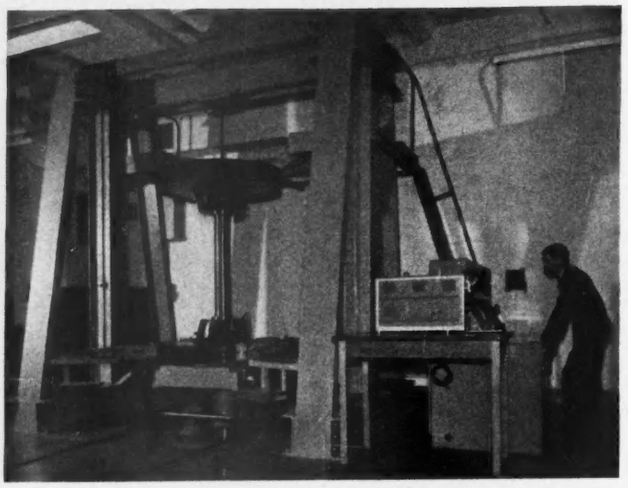
The cardinal feature of the work of the laboratory is its wide variety, not only in respect of the materials handled and techniques employed, but also in its nature and purpose.

Much of the work is of a non-repetitive character but there are also many continuous activities. Among these may be mentioned the control of quality of supplies of all types of materials, ranging from metals to adhesives. This involves the preparation of material specifications for use as the basis of contracts, etc., advising the supplies department on the relative merits of alternative products, and the testing of samples of deliveries to ensure maintenance of prescribed standards. Another branch of regular work consists of technical control and advisory services in relation to works processes, such as metal protection, cleaning, spray painting and stove enamelling, welding, heat treatment and electrodeposition. Further examples of well defined activities are the constant examination of factors affecting fuel consumption of buses, and the system of checks maintained to ensure that exhaust emission from these vehicles remains unobjectionable.

Much attention is given to keeping abreast of the latest technical developments in all types of materials and processes, with a view to assessing their likely interest to London Transport at the earliest possible stage. Thus, work is always in hand with new developments in such fields as surface protection, lubricant additives, plastics and textiles. Well established collaboration with using departments facilitates the conduct of works and service trials with those items which appear promising as a result of preliminary laboratory tests.

Perhaps the largest group of activities consists of the *ad hoc* investigation of day-to-day problems. The matters investigated may include such diverse items as failure of metallic components, lubrication difficulties, water leakages, defects in air systems, unsatisfactory paint application, ticket issuing machine performance, deterioration of rubber, corrosion of metals, staff complaints and the provision of information required by the medical department.

Longer term investigations in the nature of technical research are also undertaken, frequently involving the careful planning of service experiments in conjunction with laboratory work. Illustrations are provided by the well known activities of the laboratory in the field of lubrication, such as the pioneer work on the use of low viscosity engine crankcase oils and special rear axle lubricants which has led to significant fuel saving in bus operation; work on the design and construction of lead acid accumulators; and the measurement and analysis of stress loading of railway equipment under service conditions. In planning the new laboratory, the aim has been particularly to promote the further development of this aspect of the work.



A machine has been developed for studying the resonant fatigue life of railway axles when submitted to rotating bending stresses.

ENGINEERING IMPROVEMENTS

By far the greatest expansion that has been afforded by the new laboratory is in the facilities that are now available for engineering research. In recent years much work has been done in assisting engineering departments in the investigation of problems, notably by application of strain gauge techniques, and this side of the work hasb een considerably increased. Equally important, provision has now been made for major engineering research to be carried out within the laboratory. In the first instance, attention will be concentrated on work with a machine for studying fatigue in railway axles. This machine has been designed and constructed under an extramural research contract at the University of Nottingham.

The engineering section is also concerned with measurements of the mechanical and electrical properties of many types of non-metallic materials; with the development and application of non-destructive test methods of examination of engineering components; and with investigations into the behaviour of items of equipment under conditions in service and under controlled laboratory conditions respectively.

Typical of materials regularly tested for compliance with specification are rubber and plastics, safety glass, paper, cork tiles and electric insulating materials. With regard to the latter, the new laboratory accommodation has made possible the provision of high-voltage test equipment capable of providing an adjustable voltage up to 50 kV at mains frequency, for applying breakdown tests to insulating materials of all kinds including insulating oils.

Facilities for photometric testing of electric lamps have been increased by new life test racks which are capable of operation at any desired voltage from a regulated source of supply. This will allow accelerated life tests to be made, the results from which will be compared with those obtained from service tests. This section is particularly concerned with lamps used on buses and coaches and it is of interest to mention that all vehicles operating from the nearby Turnham Green Garage are equipped with experimental lamps under laboratory control. Facilities are also provided for photometric testing of complete units such as headlamps, fog lamps and tail-light assemblies.

The section is also concerned with the performance of electrical storage batteries, the assembly and re-building of which is undertaken in the Chiswick Works of the chief mechanical engineer (road transport).

This moment has been chosen to improve facilities for testing such batteries and their components by the installation of a series of test-units which will permit batteries to be subjected to charge and discharge tests, at both normal and high rates, and also cycling and overchange life tests with a view to correlating such laboratory investigations with the results of service tests on similar batteries. Several hundred buses in London Transport's fleet are currently fitted with experimental batteries under laboratory control, but with the increased life now being obtained from batteries it is inevitable that such service tests take a very long time. It is hoped that the additional laboratory facilities may in due course enable information to be obtained more quickly.

The experience gained with a small cold chamber during the past few years has demonstrated a considerable demand for this facility and the opportunity has been taken to install a larger cold chamber in the new laboratory. Its internal dimensions are 14 ft by 9 ft by 8 ft high and the refrigeration equipment enables the temperature within the room to be maintained at any desired level down to about 0° F. This improved cold chamber is likely to prove particularly valuable in connection with problems encountered in cold weather with the operation of compressed air equipment, water cooling and heating systems, and ice formation on rails.

New Metals for Radio Valves

Development work in the radio valve industry has long since reached the point where progress is very largely dependent upon the development of new materials and production techniques, rather than geometrical design.

As a step toward new and better materials, research engineers at the Battelle Memorial Institute, Ohio, USA, have recently been investigating the properties of columbium and hafnium. Each of these materials is ductile, gas sensitive and has a high melting point (columbium 2,145° C, hafnium 2,222° C).

Although their research work is still in progress, the Battelle technologists have reached the following conclusions about the possible use of these metals in radio valves.

(1) Columbium and Cb-0·65Zr and Cb-40Ta alloys show moderate room temperature strengths and exceptionally good ductility in both the cold-worked and annealed conditions.

(2) At 1,000° C, the columbium alloys are considerably stronger than the unalloyed metal, and the Cb-0·65Zr alloy appears to be outstanding.

(3) Resistivity/temperature relationships for columbium and its alloys (mentioned above) show roughly parallel behaviour from 25 to 1,700° C. As would be expected, the resistance values for the alloys are much higher at all temperatures.

(4) On the basis of its good workability, hot strength and ease of welding the Cb-0·65Zr alloy shows excellent promise as a high-temperature structural metal for valves.

(5) Hafnium and hafnium-based alloys require hot working during initial breakdown of the arc-welded ingots and special protection from atmospheric gases is needed during their processing to thin wires and fine sheet.

(6) The strength of hafnium is considerably improved by binary alloy additions of 1 to 5 per cent of aluminium. columbium or molybdenum.

(7) The best combinations of hot workability cold wire-drawing characteristics and strength and ductility were found in hafnium alloys containing 2·5 to 5 per cent columbium. Because of their gas sensitive nature and anticipated low secondary emission coefficients. these alloys show considerable promise as grid anode materials for radio valves.

Infra-Red and Ultra-Violet Television Cameras

A television camera tube which can "see" a burglar prowling around a bank in the dark, or observe the nocturnal habits of owls and bats, is now being manufactured by E.M.I. Electronics Limited, Hayes, Middlesex. It is an infra-red sensitive vidicon tube of standard dimensions, so that it will fit into any ordinary vidicon television camera. In both these applications the scene must be illuminated by one or more infra-red lamps.

The infra-red camera tube can also "see" temperature without the use of infra-red lamps. When an object—such as a steel plate—is heated up from room temperature, it begins to radiate infra-red light. The tube can begin to see the object as it reaches 450° C, and gives a fully-bright picture at higher temperatures. The human eye can only detect a dull red glow at 450° C after the observer has been in the dark for some minutes. An oscilloscope can be used in conjunction with the camera to measure the temperature of the object, to a high degree of accuracy. This application of the infra-red camera tube should have many uses in industry.

Another interesting new E.M.I. tube is an ultra-violet sensitive vidicon tube. The main use of this tube is to obtain television pictures from an ultra-violet microscope.

The limit of usefulness of optical microscopes is set by the wavelength of light. Objects so small that they approach in diameter the wavelength of light do not reflect any light so are not visible. They can be observed under specially designed microscopes by using ultra-violet light, which has shorter wavelengths than visible light. Special quartz lenses are used.

When using such microscopes, a visible picture can be obtained by attaching a television camera with an ultra-violet sensitive vidicon tube to the microscope. This avoids the delay and expense of taking numerous photographs until the required picture is obtained. It also reduces the damage to biological specimens caused by excessive exposure to ultra-violet light.

Both infra-red and ultra-violet tubes are also sensitive to visible light, so cameras can easily be set up by ordinary lighting. A further advantage of using a television camera is, of course, that large audiences can view the subject simultaneously—if necessary at several different locations and at a considerable distance from the scene under observation.

Runway Arrester for Large Aircraft

A simple airport runway installation, to ensure greater take-off and landing safety for large commercial jet transport aircraft, has been proposed by the Nortonics Division of the Northrop Corporation in the USA.

The system, called "Decel," is an aircraft deceleration basin designed to prevent large jet aircraft from overshooting the runway during landing and takeoff.

Describing the new concept, Dr. W. F. Ballhaus, vice president of Northrop, said. "Out basic objectives in developing Decel are safety and economy. Not only will it improve safety of operations but the system will save the costs involved in constructing exceptionally long runways. In areas where there is no room to extend runways, it will make possible safe jet operations where they are not possible today."

After a lengthy programme of study, analysis and tests, Northrop engineers say that they are convinced that the Decel technique offers the best solution to the problem of arresting large commercial high-speed aircraft.

The Decel system consists of a shallow water-filled basin with a strong, flexible cover installed at the windward end of the runway. Jet aircraft that would otherwise overshoot the runway, during a landing or takeoff attempt, simply roll into the Decel basin. The process of depressing the flexible cover and displacing a large volume of water then slows the aircraft down to a safe stop.

A preliminary computer analysis of the Decel concept, using specifications for the DC-8, 707, and 600 model jet transports, has been conducted by Northrop. Results indicate that, at an entry speed of 75 knots, a Decel basin of 600 to 700 ft in length would effectively stop a large jet aircraft without reverse thrust, without brakes and without damage.

At the request of the US Federal Aviation Agency, scale model tests have been conducted by the US National Aeronautics and Space Administration to compare the open water method with Northrop's covered basin technique. These tests showed the Decel concept to be superior in that it brought aircraft models to halt in shorter distances.

The Northrop International Corporation have proposed that the US Federal Aviation Agency should sponsor a full-scale test of the Decel concept in the near future.

Calculable Capacitor for Electrical Standards

In precise determinations of the ohm by various national laboratories, the starting point has usually been an inductance whose value is calculated from its measurements.

Various experiments in recent years have considerably improved the accuracy with which the speed of light can be determined and this has revived interest in developing a capacitor, the value of which can be calculated from its dimensions.

With this as a starting point, the absolute value of the ohm can be determined by using the velocity of light to convert this value of capacitance, calculated in electrostatic units, into electromagnetic units.

The Commonwealth Scientific and Industrial Research Organisation has recently been developing and constructing such a capacitor. It is now complete, and special techniques and equipment have been devised to determine its characteristics. The associated project of determining the absolute value of the ohm is now in an advanced stage.

This project, when completed, will make Australia self-sufficient in this particular field of standards work and may also make a valuable contribution to the accurate determination of primary electrical standards.

Microwave Valves of High Power

The formation of a high-power, microwave valve laboratory and the development of two important new valve types have been announced by the U.S. General Electric Company.

The new valves incorporate unique developments in the fields of linear-beam and cross-field devices which make possible high-power, radio-frequency sources. They are the "multiple-beam klystron," which combines a number of beams in a single radio frequency structure within a vacuum, and the "orthotron," a novel crossfield valve employing travelling waves and permitting substantial increases in power capacity, particularly for micromicrowaves.

High-power, r.f. technology will affect the development of nearly all areas of electromagnetic science, including radioastronomy, space satellites, space probe tracking and deep space command and communications systems, as well as long-range radar.

General Electric's new microwave laboratory has been established to carry out applied research, advanced development and product design in this field. The laboratory is headed by Dr. E. D. McArthur, holder of 64 patents and inventor of the radar "lighthouse" tube (planar triode) which was extensively used in the Second World War.

Ultra High Strength Glass from Russia

Glasses which are lighter than aluminium, harder than high carbon steel and five times as strong as conventional material are said to have been produced at the State Institute for Glass, Moscow. All of the new glasses are claimed to be able to withstand temperatures of up to 1,000° C and some do not melt below 1 500° C. In terms of abrasive resistance one ton of glass can evidently replace something like five tons of metal.

The report[1] which gives these results does not mention the method of manufacture or treatment but an earlier paper[2] suggests that it should be possible to obtain ultra high strength material by subjecting ordinary glasses to various physical and chemical treatments. These include atomic bombardment to produce a denser structure, the use of very high pressures, replacement of some of the large potassium and sodium ions by smaller lithium ions and possibly by the introduction of calcium sulphide or organic molecules.

Needless to say, if such materials were to become commercially available they would revolutionise many aspects of the building automobile, aircraft and general engineering industries.

[1] A. Orlov, *Pravda*, 15 Sept., 1960. (In Russian).
[2] S. M. Brekhovskikh, *Steklo i Keramika*, July, 1960. (In Russian).

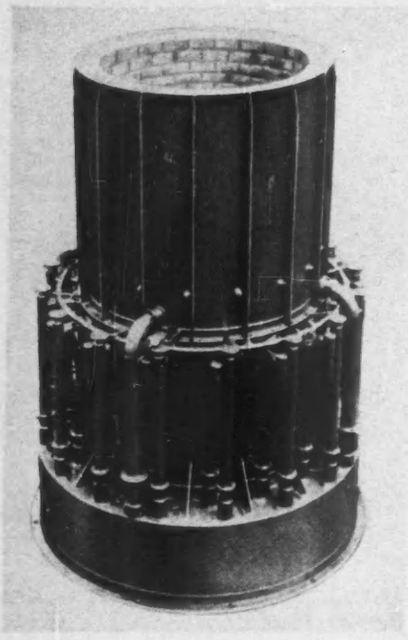
Three Steps towards Good Combustion

Combustion engineers are constantly striving to improve techniques to give more efficient use of fuels by more complete combustion, and elimination of smoke and smuts from the exhaust gases.

ONE aid to more complete fuel combustion has been developed by Urquharts (1926) Limited of Wadsworth Road, Perivale, Greenford, Middx. It concerns a new type of combustion chamber and firing system which is said to give smoke-free combustion.

Complete Combustion

An aerodynamic toriodal system has been evolved giving a high combustion intensity and completeness of mixing through a wide range of fuel/air and turn-down ratio variations. It is claimed that complete burning of liquid fuels results with flexibility and full control and the makers say that any type of flame can be provided to suit any furnace or boiler.



This refractory chamber gives more efficient use of heavy grade fuel and more complete combustion with elimination of smoke and smuts from the combustion gases.

Basically, a specially designed cylindrical refractory chamber enables the bulk of the combustion air to enter in reverse flow to the fuel. A toriodal pattern is generated and sustained in the chamber. The atomised fuel and combustion air circulate in the toroid thoroughly mixing and burning to completion within the combustion chamber.

In this system a considerable amount of preheating is obtained. The high velocity reverse flow air draws partly burned products into the toroid and these are heated as they mix with the air. In addition the air scrubs against the walls, is heated up, and keeps the refractory temperature down.

With liquid fuels, as the particles of oil leave the atomiser they are subjected to intense radiation from the flame. This results in almost instantaneous vaporisation, and cracking and vapour-phase burning in the highly pre-heated air develops immediately, with consequent smoke-free combustion.

For higher temperatures and greater drying capacity Urquharts have developed a two-stage unit rated at 35 million Btu per hour with a turn down ratio of 5 : 1. In the lower chamber of this unit the combustion air is preheated to approximately 1,000° C. Any gases which are not completely burned pass into the centre of the upper chamber where they are drawn out to the sides by the rotating action of a variable supply of extra air fed in through semi-tangential jets. Complete combustion of this turbulent mixture is obtained with the additional air.

Under test it was found that the temperature of the gases was uniform over the whole cross-section of the mouth of the chamber. No significant variation in temperature or in gas composition was detected in a traverse across the outlet. These tests were carried out in the company's Bristol works. Any residual carbonaceous particles remaining after the cracking of each particle of oil are extremely small and at the unusually high temperature prevailing in the preheated air/vapour flame, their combustion is rapid and complete. Readings obtained from the tests indicated a complete and clean burning of even the heaviest residual oils.

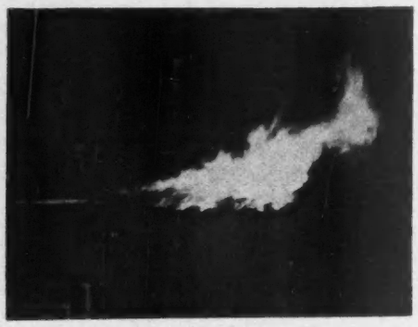
Independent tests were undertaken at the BP Fuel Laboratory at Sunbury-on-Thames and the results gave the equivalent of 1·6 mg per cu. ft of solids. The total solids represented only about 0·1 per cent of fuel input.

Better Burner Design

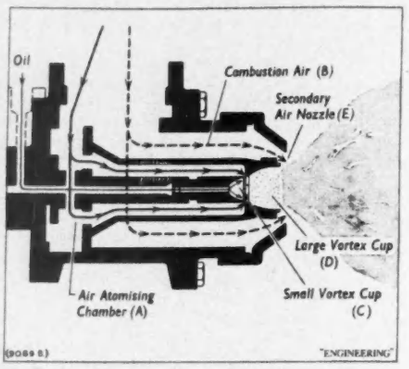
A reduction of 15 per cent oil consumption and increased efficiency of furnace operation is claimed for a new design of self-proportioning oil burner.

The burner differs from its contemporaries by virtue of its twin vortex cups. Oil from a conventional burner does not atomise until it has travelled some distance into the furnace, leaving a relatively cold area in the vicinity of the burner nozzle. Thus full combustion does not take place. Attempts have been made to overcome this disadvantage by projecting a stream of air from the side of the furnace opposite the burner nozzle to produce earlier atomisation and combustion. In practice, however, it has been found that this produced a fierce ball of flame in the centre of the furnace, resulting in heavy scaling of the metal being treated and two relatively cool areas at each end of the furnace.

These problems have been overcome say the manufacturers of the new burner, Premier Oil Burners, Eastbourne Street, Walsall, Staffordshire, by the provision of the twin vortex cups and of a separate chamber for atomising air—(A) on the—drawing which emerges at high velocity around the orifice of the oil nozzle. This atomising air is unaffected by the normal air/oil control valves and consequently remains at constant pressure irrespective of the position of the air valve.



Extra atomising air flow is given by the Premier burner, which results in fuller combustion.



This propane-fed spark ignition torch gives certainty of ignition to oil-fired industrial boilers.

The combustion air (B) passes through a peripheral port in the air valve which is so arranged that a high swirling motion is imparted to the incoming air which mixes with the atomised oil at the burner orifice giving perfect conditions for combustion. Oil emerging from the oil tube is broken up by air passing across the outer edge of the small vortex cup (C). Atomising air emerging from the centre chamber picks up the oil from the small vortex cup and the resultant air/oil mixture is finally atomised in the larger vortex cup (D). This highly atomised mixture is then directed by the secondary air nozzle (E), through the burner into the furnace where it combusts immediately.

The oil is controlled by a precision machined V-slot cut on the periphery of the plug valve and adjustment of the oil/air mixture is effected by holding out a spring operated plunger on the air handwheel and reducing or increasing the oil supply by turning the handwheel. When a satisfactory flame has been established the plunger is released and both air and oil valves will then work in unison over maximum and minimum throughput.

The burner may be mounted at any angle to suit furnace requirements and is suitable for all grades of oil. In practice it has been found that savings of up to 2 gph against a normal consumption of 7 to 8 gph have been reached and the smoke problem which is present due to incomplete combustion eliminated.

Three models covering a comprehensive range of furnace and heating applications are available.

Certainty of Ignition

One of the difficulties of igniting oil-fired automatic industrial boilers is that of flame instability caused by draught conditions wit hin the boiler. A spark ignition torch fed by liquefied-petroleum gas is said by the makers to overcome this problem.

Two sizes of this torch are now available from the industrial division of Calor Gas (Distributing) Company Limited, 161 Oxford Street, London, W1. The small size—known as No. 7—gives a 7 in flame and the larger size (illustrated)—known as No. 36—gives a 36 in flame.

Both sizes work on a system of primary and secondary flames, the primary one being ignited by a spark electrode plug. The primary flame in turn ignites the secondary flame stabilising it at its root.

Among the advantages which the makers claim for the torches are absolute certainty of ignition by virtue of a carefully controlled mixture of gas and air, and a sparking point which is inside the nozzle where it is well protected against contamination by oil and carbon.

Low pressure propane gas for the torches is supplied under regular exchange by the makers.

Helical and Spur Gears for Specified Centres

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This article presents data based on BS 436-1940, "Machine Cut Helical and Spur Gears," enabling a direct approach to gear design. The data are intended primarily for the design of gears for specified centre distances but may be applied also to gear design in which centre distance is of no consequence.

The design equations and data presented in BS 436 favour the design of gears for non-specified centre distances; in such cases it is usual to commence by assuming the number of teeth in the pinion and wheel, the latter being fixed by the gear ratio. However, when a specified centre distance is required, the initial design data are the pinion and wheel pitch diameters and not the numbers of teeth. Hence, it is more convenient to rearrange the horsepower equations in BS 436 to relate numbers of teeth and gear pitch diameters as follows:—

For wear of the wheel

$$\frac{T^{1\cdot8}}{Z} = \frac{X_c S_c D^{2\cdot8} N C_f}{126{,}000 \times \text{horsepower}} \quad . \quad (1)$$

For strength of the wheel

$$\frac{T^2}{Y} = \frac{X_b S_b D^2 N C_f}{126{,}000 \times \text{horsepower}} \quad . \quad (2)$$

(t, d and n replace T, D and N respectively in the above equations for wear and strength of the pinion).

In the design equations C_f is the face width coefficient and is equal to the product of the face width F and the diametral pitch P. All other terms are as defined in BS 436. For reasons of proportion, it is recommended that C_f should range between 8 and 12·5 for straight spur gears. However, higher values are common for helical gears.

Six charts have been prepared, one of which is reproduced, based on the above equations giving strength and wear factors for both straight spur and 30° helical pinions and wheels; the charts cover gear ratios ranging from 1 to 10. The use of appropriate correction factors allows the charts to be used for any helix angle.

F. G. Watts arranged the design equations in similar form and prepared three charts giving the strength and wear factors for straight spur and 30° helical pinions.[1] The design procedures adopted in the present article are based on the six charts and may be regarded, therefore, as an alternative to the method suggested by Watts.

When an exact, non-standard centre distance is required using gear cutters of standard pitch, it is necessary to use extended cutter settings. For straight spur gears, the cutter setting corrections δ_{cp} and δ_{cw}, for the pinion and wheel respectively are obtained from the following equation :—

$$(\delta_{cp} + \delta_{cw}) = \frac{(t + T)(\text{inv}\,\psi_r - \text{inv}\,\psi_c)}{2\,P \tan \psi_c} \quad (3)$$

where ψ_c = cutter pressure angle = 20°

ψ_r = running pressure angle

$= \cos^{-1} \dfrac{C_s}{C_r} \cos \psi_c$.

C_s being the standard ccentre distance and C_r the running centre distance

P = diametral pitch

inv ψ_r = involute function of the running pressure angle

inv ψ_c = involute function of the cutter pressure angle

For helical gears, it is necessary to consider the diametral plane, that is, the plane perpendicular to the axis. In this case, the cutter setting corrections are given by

$$(\delta_{cp} + \delta_{cw}) = \frac{(t + T)(\text{inv}\,\psi_{dr} - \text{inv}\,\psi_{dc})}{2P \tan \psi_{dc}} \quad (4)$$

where ψ_{dr} = running pressure angle

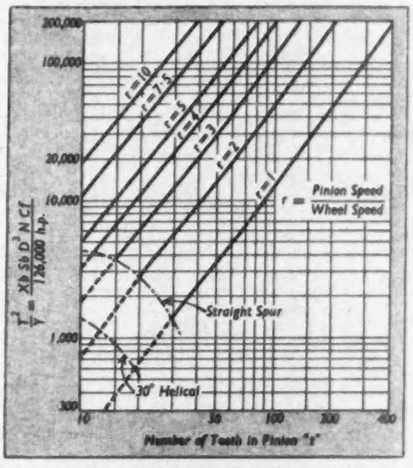
$= \cos^{-1} \dfrac{C_s}{C_r} \cos \psi_{dc}$

ψ_{dc} = cutter pressure angle in the diametral plane = $\tan^{-1}$ (tan ψ_c sec σ), σ being the helix angle.

Many methods may be adopted for the distribution of the cutter settings. Merritt suggests that the corrections be distributed in such a way as to make the actual addenda of the teeth in the same ratio as the addenda of teeth with normal correction[2]. For instance, for the normal correction $K_p = -K_w = 0{\cdot}4\left(1 - \dfrac{t}{T}\right)$ which is applicable when $(t + T)\sec^3\sigma > 60$, the following equation applies:—

$$\frac{a_s + \delta_{cp} - \frac{1}{2}(d_r - d_s)}{A_s + \delta_{cw} - \frac{1}{2}(D_r - D_s)} = \frac{7R - 2}{3R + 2} \quad . \quad (5)$$

where a_s and A_s are the standard addenda (equal to $\dfrac{1}{P_n}$) of the pinion and wheel; d_r and D_r are the running pitch diameters of the pinion and wheel; d_s and D_s are the standard pitch diameters of the pinion and wheel; R is the gear ratio (equal to $\dfrac{T}{t}$).



Strength relationship for gearwheels—straight spur and 30° helical.

Equation (5) may be solved simultaneously with equation (3) or (4) to find δ_{cp} and δ_{cw}. Note that to avoid interference δ_{cp} should be made equal to or greater than the BS 436 normal correction.

Design procedures are given for the design of gears for both specified and non-specified centre distances. Each procedure is illustrated by a typical design example set out in a convenient tabular form.

[1] Watts, F. G. "Design of Spur and Helical Gears to Operate at Pre-determined Centre Distances," *Machinery*, Dec. 16, 1948.

[2] Merritt, H. E. *Gears*, Second Edition, Sir Isaac Pitman and Sons Limited, London, 1946.

Photocopies of the full paper, of which the above is a digest, are available from the publisher, ENGINEERING, 36 Bedford Street, London, WC2, price 7s 6d post free. Orders should be accompanied by a remittance.

Projector has High Light Output with Efficient Cooling

Projection equipment installed at the Royal Aeronautical Society's new lecture theatre has been supplied by AEI Sound Equipment Limited, Crown House, Aldwych, London, WC2. The installation includes Xenon 16 mm and slide projectors, arc rectifier equipment, twin motorised roller screen unit and other ancilliaries.

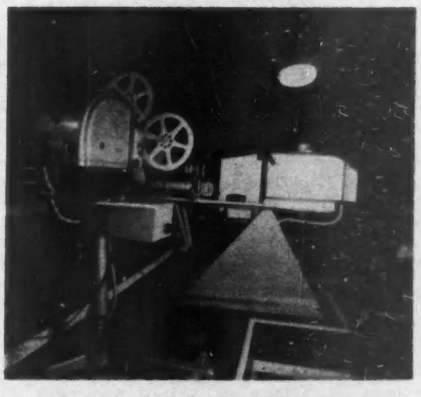
The premier xenon slide projector, developed by Robert Rigby Limited, in conjunction with AEI, incorporates the type of AEI lantern used on 35 mm projectors in commercial cinemas. The unit, claimed to be the first of its kind in the country, is capable of a light output 5 to 6 times greater than that of a conventional 60 A carbon-arc slide lantern.

It is designed to accept all standard sizes of slides and the cooling system allows colour transparencies to remain projected for periods in excess of 30 minutes without damage, despite the high intensity of light. Instantly interchangeable projection lenses of 3 different focal lengths maintain a constant picture height for 3¼ and 2 in square slides, shown vertically or horizontally. A swing-over turret unit permits speedy changeover of the slide carriers and of the optical systems.

Mounted on a pedestal base is another projector which is equipped for both optical and magnetic sound reproduction as well as providing facilities for recording on to magnetic stripped film from a variety of inputs. This projector is known as the AEI 451-X 16 mm Xenon projector and uses a Mazda 2 kW xenon lamp.

The screen unit comprises two 12 ft square white opaque screens on steel rollers which are driven by in-line electric motors and fitted into a single housing-box. Push button operation is provided on stage and in the projection room. One screen is unmasked for slide projection while the other is masked in to a normal ratio 16 mm picture. The screens were made by the Perforated Front Projection Screen Company Limited.

The Premier editing bench is fitted with film wells, twin rewinders, two-way synchroniser, boxes and viewer.



Projection room at the Royal Aeronautical Society's new lecture theatre.

Power in the Garden

THERE is no doubt that gardening can be very hard work, and expensive too if much help has to be hired. The basic answer is to use power tools—there are several makes on the market—as evidenced at the recent Smithfield Show. If you happen to live in Mansfield (Notts.), you can hire one from the Urban Council.

Most of these mechanical cultivators follow the same accepted pattern and consist of a machine with many attachments. An example of the larger ones is the Howard Rotavator, made in several versions. Model 700 is shown in the first illustration, which also shows how a tricky corner can be cultivated. The machine is in effect a hand controlled tractor; it may be equipped with a Rotavator, a single furrow plough, a cutter bar, or a tool bar. The speed range is from ½ to 13 m.p.h. and a 1 ton trailer makes it suitable for transport on large holdings.

A somewhat smaller machine is the Merry Tiller Major shown in its basic form in the second illustration. It is powered by a Briggs and Stratton 2½ h.p. four stroke engine driving through a clutch and V-belt and a roller chain to the main shaft. Three-position adjustable handles can be fitted if required. A heavy duty rear skid can be used when cultivating, enabling the wheels, which are 8 in diameter by 1¼ in wide, to be used to steady the machine. The working weight is 94 lb and the basic rotors provide the forward propulsion for the machine.

The basic rotors cultivate a strip from 12 in wide, using one pair, to 44 in wide, using four pairs. Penetration is up to 12 in deep. They are the general purpose tools for seed bed preparation, ploughing, discing, and harrowing. The depth of cultivation is controlled by the amount of pressure placed on the handles: a light pressure giving shallow penetration and vice versa. An unusual application, but one well within normal requirements, is to tow a motor car, a job that the Tiller will perform easily.

Awkward corners can be reached with the Howard 700 Rotavator.

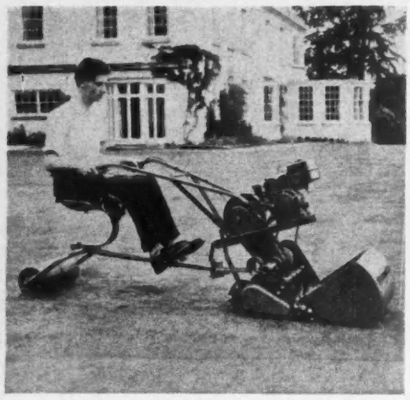
Angle rotors can be used in place of the basic tine type, and 10 in solid traction wheels can be fitted to convert the machine into a tractor, for which a whole range of tools is available. These include a furrower, ridger, hoe blades, duck-foot harrow and 5-pronged weeder, all fitting in place of the rear skid.

For rough work, a rotary grass cutter can be fitted at the front of the machine using either the wheels or the angle rotors for propulsion. For the lawn, however, a true cylinder mower is attached as shown in the third illustration. With the trailing seat added this makes light work of even large expanses of grass. The mower is a 16 in Webb machine, the positive clutch of the Tiller controlling the forward movement, and the cutters being driven through the V-Plex clutch. It is claimed that it only takes a matter of moments to attach the mower to the basic unit. The third of the cutting attachments is a sickle mower that will cut a 24 in swathe.

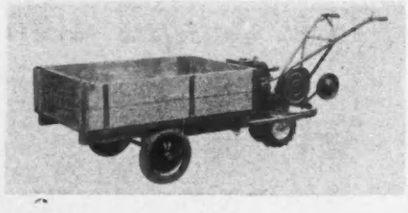
The fourth illustration shows the Tiller with the trailer attached. The body measures 4 ft by 2 ft 9 in by 11 in deep and will carry 5 cwt. Sides and back are removable and the platform will tip for discharge. No tools are needed for making the attachment. For long hauls the driver can sit on the truck.

The full complement of tools includes a flexible shaft that can be used to drive sheep shears or clippers, and also the entire range of Tarpen accessories that embraces hedge trimmers, rotary pruning saws, sanders, and polishers. There is a portable spraying plant, an air compressor for pumping up motor tyres, a hay sweep, a wide range of special purpose lawn equipment, and last but not least a 14 in saw bench that fits neatly over the Tiller and can therefore be wheeled from place to place. A heavy tubular stand that can be turned out of the way for transport provides stability during sawing. No bolts are required to make the attachment.

Many different attachments can be added to the basic Merry Tiller.



One is a 16 in Webb lawn mower with or without a trailing seat (above). Another is a tipping trailer with a capacity of 5 cwt (below).



The Howard Rotavator is made by Rotary Hoes Limited, West Horndon, Essex, and the Merry Tiller is a product of Wolseley Engineering Limited, Witton, Birmingham 6.

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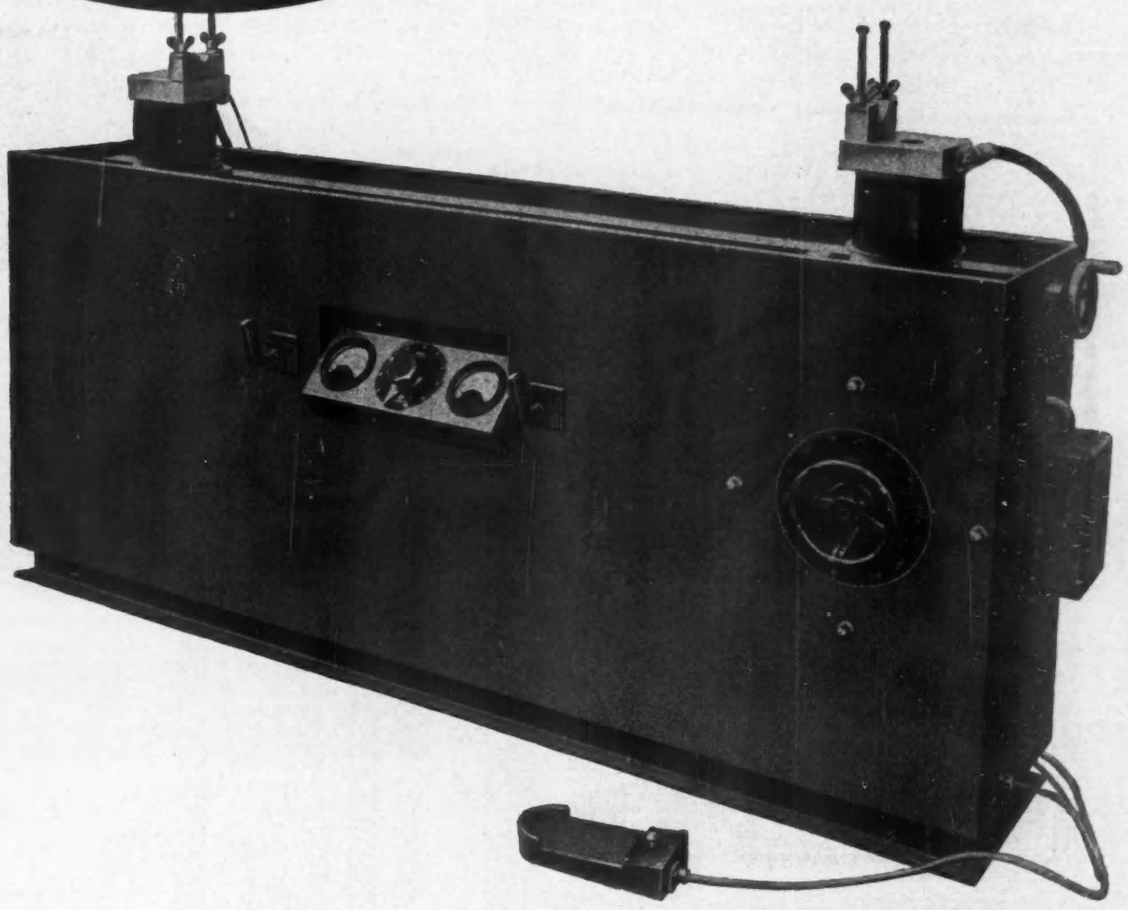

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The extremely flexible design of this new machine enables all general magnetic crack detection work to be carried out. Specimens up to 78 in. long can be accommodated.

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Instrumentation Division — Scientific Apparatus & X-Ray Department

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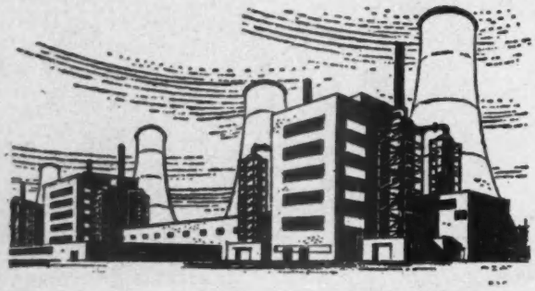
Newalls

Throughout the years Newalls have built an enviable reputation in the insulation of conventional power stations. This specialised experience is now being drawn upon on an ever growing scale in solving the complex problems of Nuclear Power Development. Recent contracts in this field reflecting Newalls supremacy are given below.



HINKLEY C.E.G.B. NUCLEAR POWER STATION

At Hinkley Point, Newalls have been entrusted with the insulation of the reactors, steam raising units, gas ducting, integral piping, etc., under contract to Babcock and Wilcox Ltd.

CHAPELCROSS U.K.A.E.A. NUCLEAR POWER STATION

Under contract to Babcock and Wilcox Ltd., Newalls have carried out the insulation of the 16 steam raising units and integral piping. The insulation of turbines, blowers, associated auxiliary equipment and piping has been carried out under contract to C. A. Parsons and Co. Ltd.

BRADWELL C.E.G.B. NUCLEAR POWER STATION

At Bradwell-on-Sea a further large contract for the thermal insulation of turbines, associated auxiliary equipment and piping (main and auxiliary turbine plants) has also been placed by C. A. Parsons and Co. Ltd with Newalls.

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Head Office: WASHINGTON, Co. DURHAM

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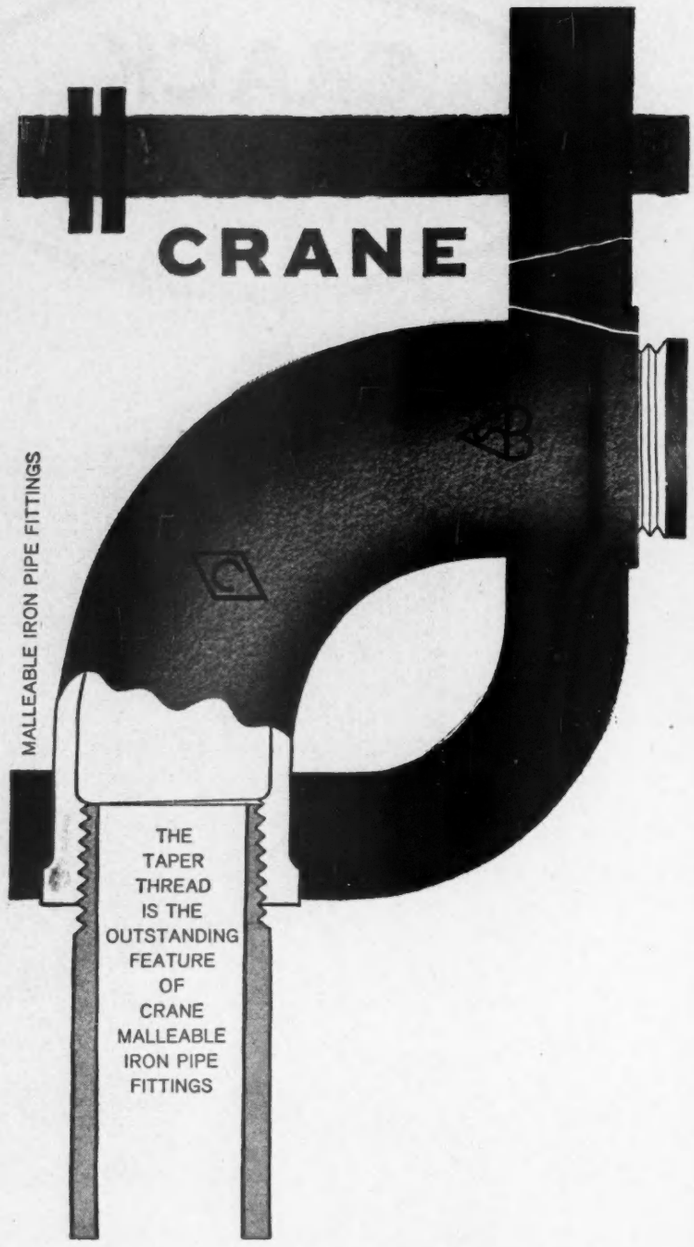
CRANE



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All Crane Pipe Fittings are inspected during manufacture and individually pressure tested at the Crane factory where they are made. That is why they give such long, trouble-free service.

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E7

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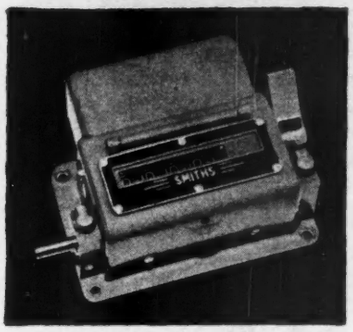

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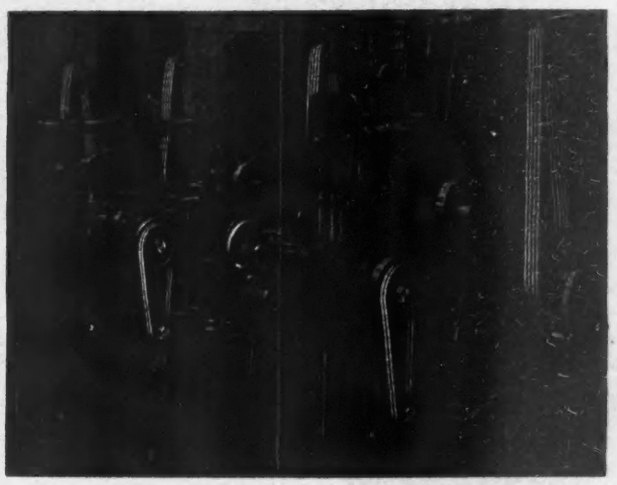

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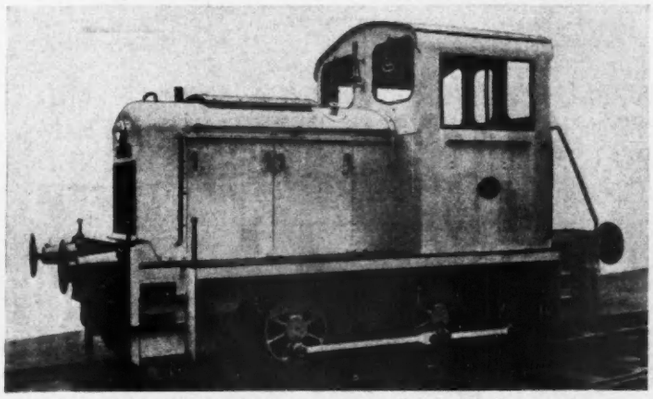
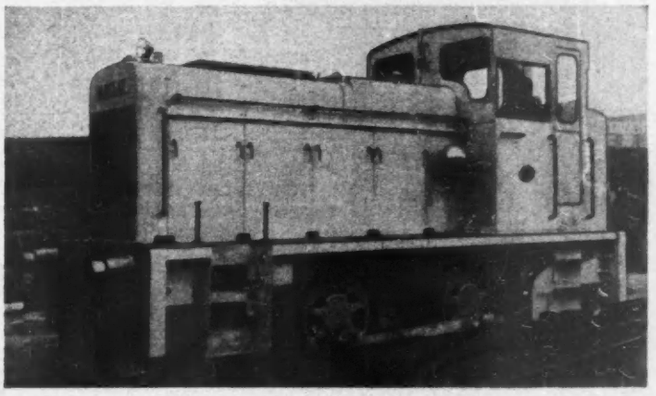


1. 85 h.p. 0-4-0 Diesel Hydraulic Locomotive, fitted with Dorman diesel engine and a Twin Disc hydraulic torque convertor. Maximum speed about 10 m.p.h., maximum tractive effort 8,160 lbs.



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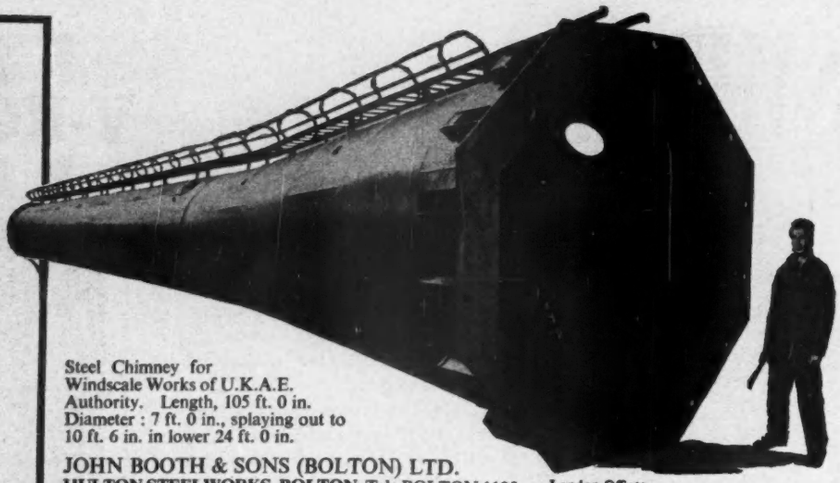

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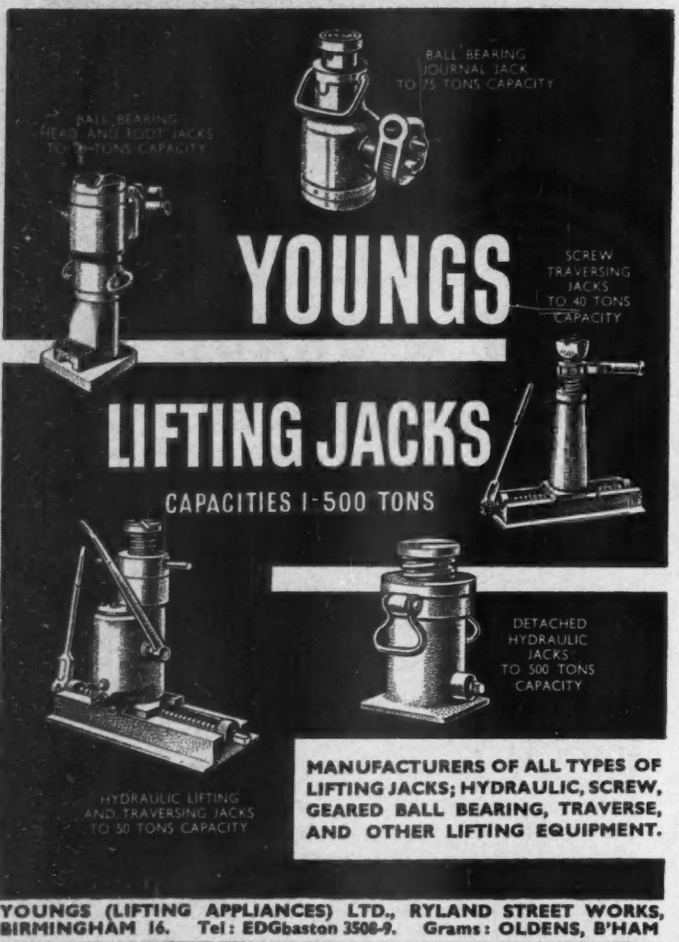
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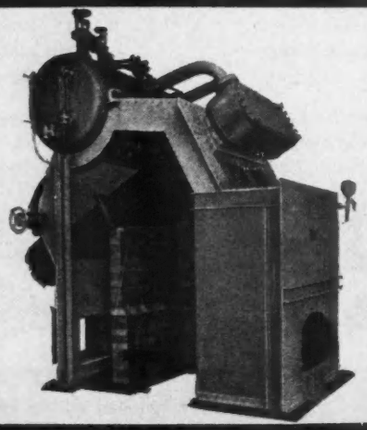

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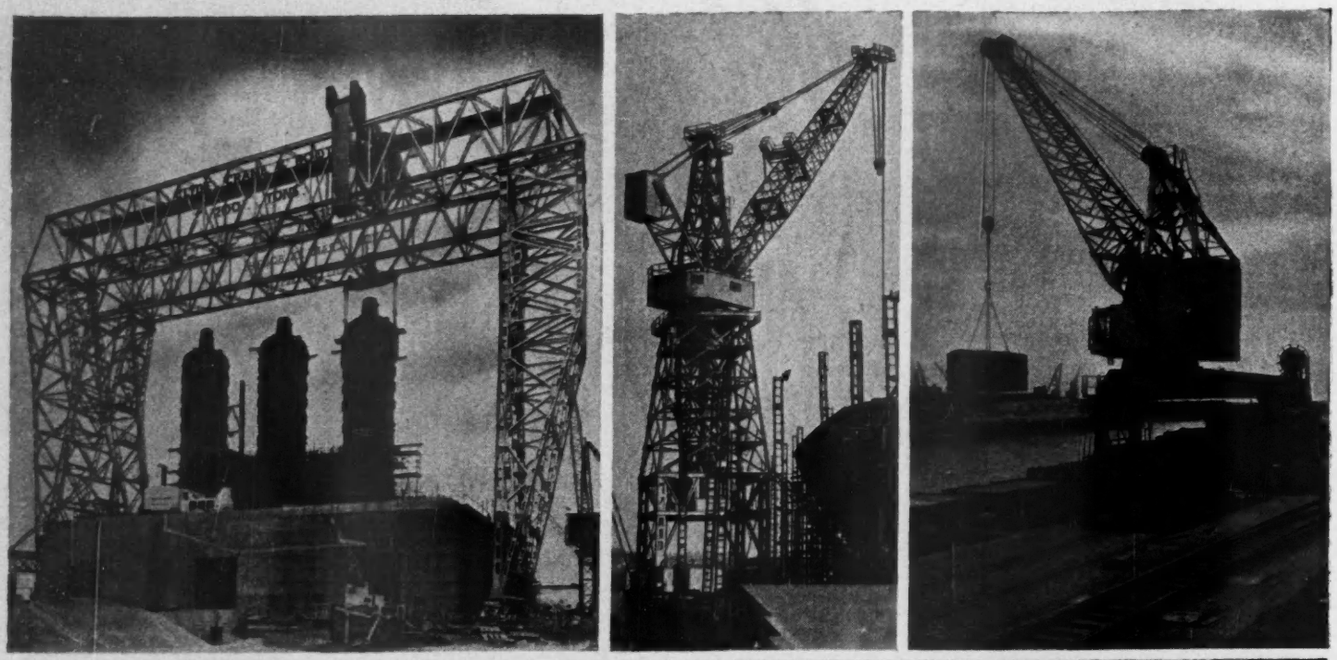

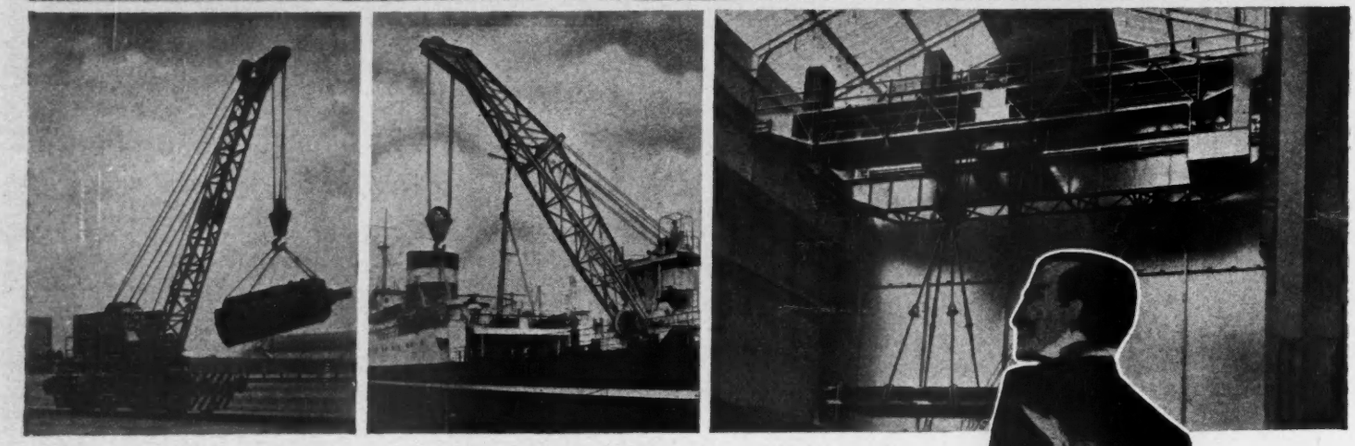

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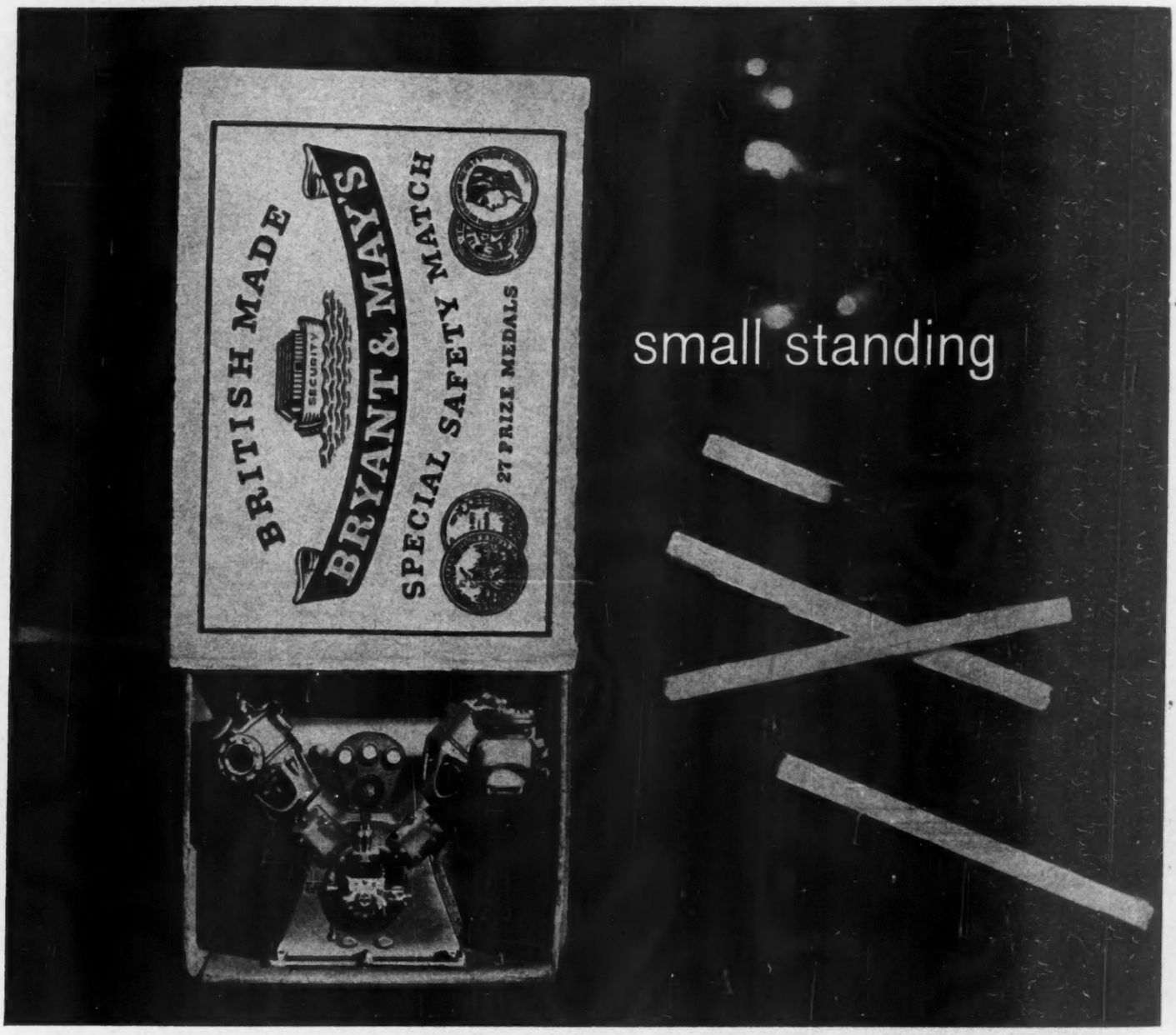

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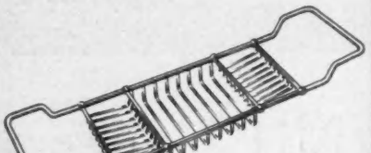
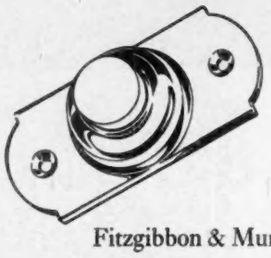

Holt, Siron & Co.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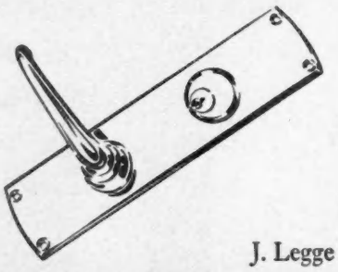
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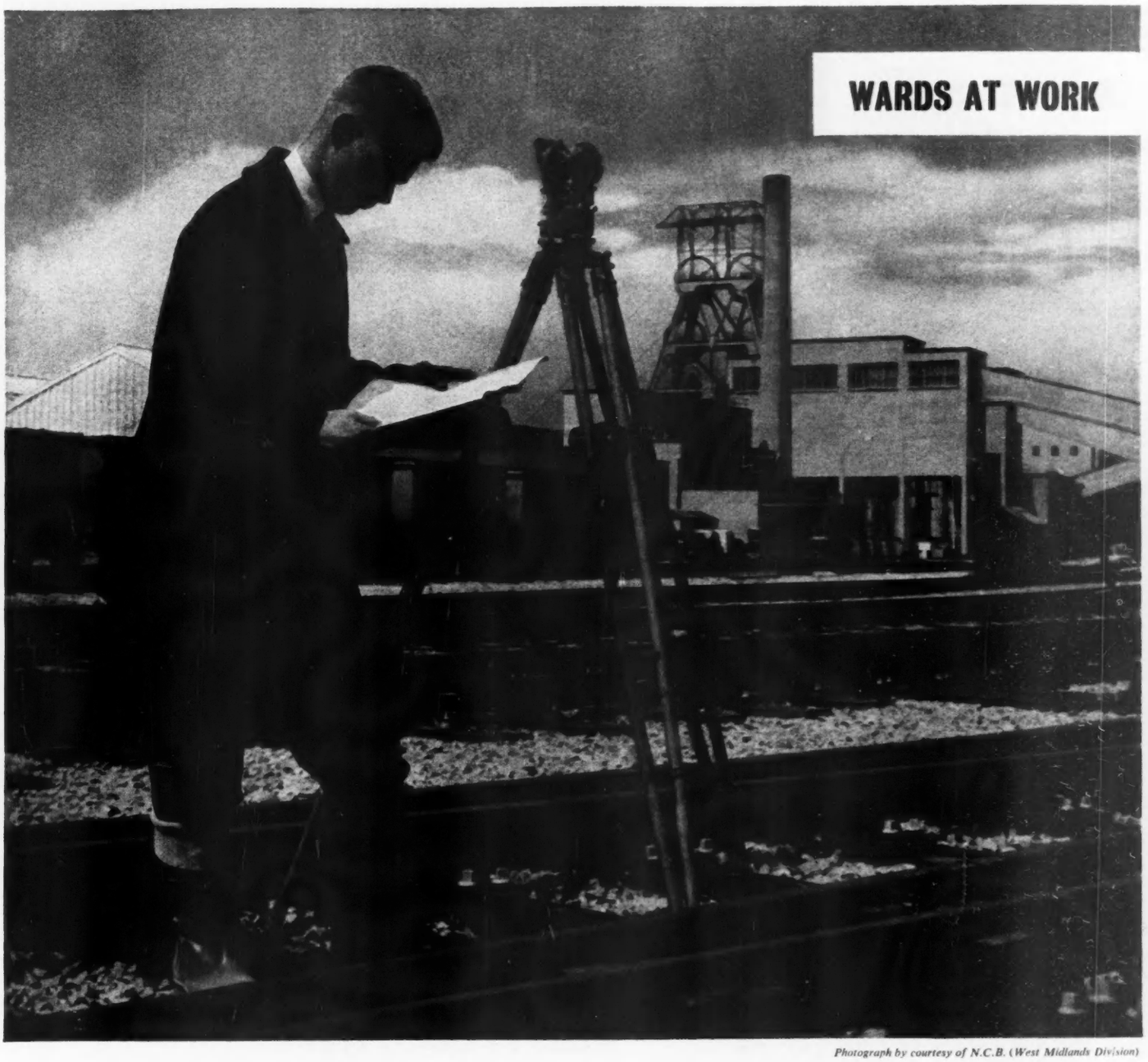

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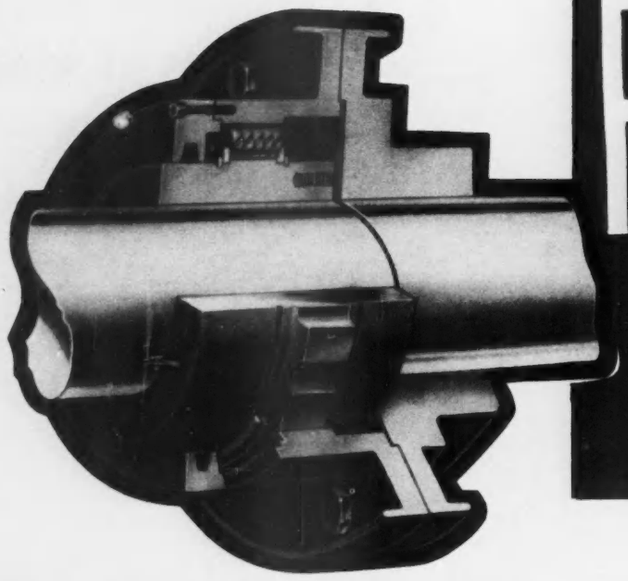

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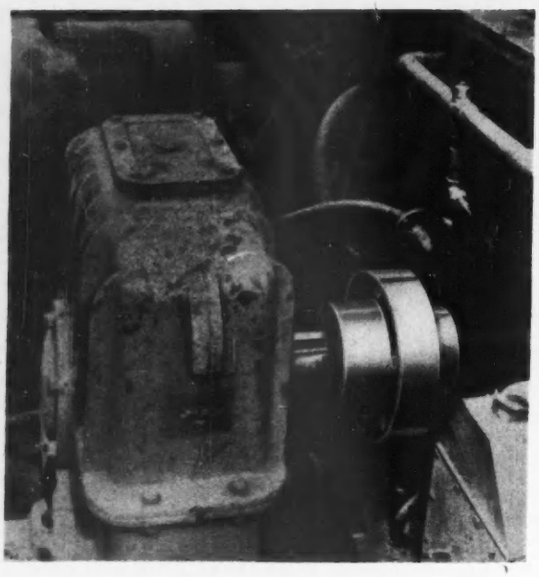

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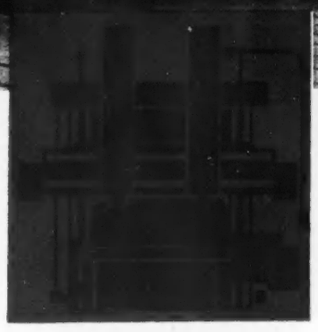

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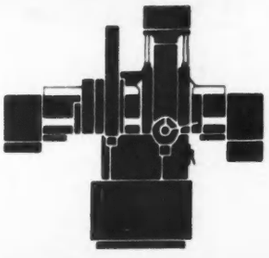

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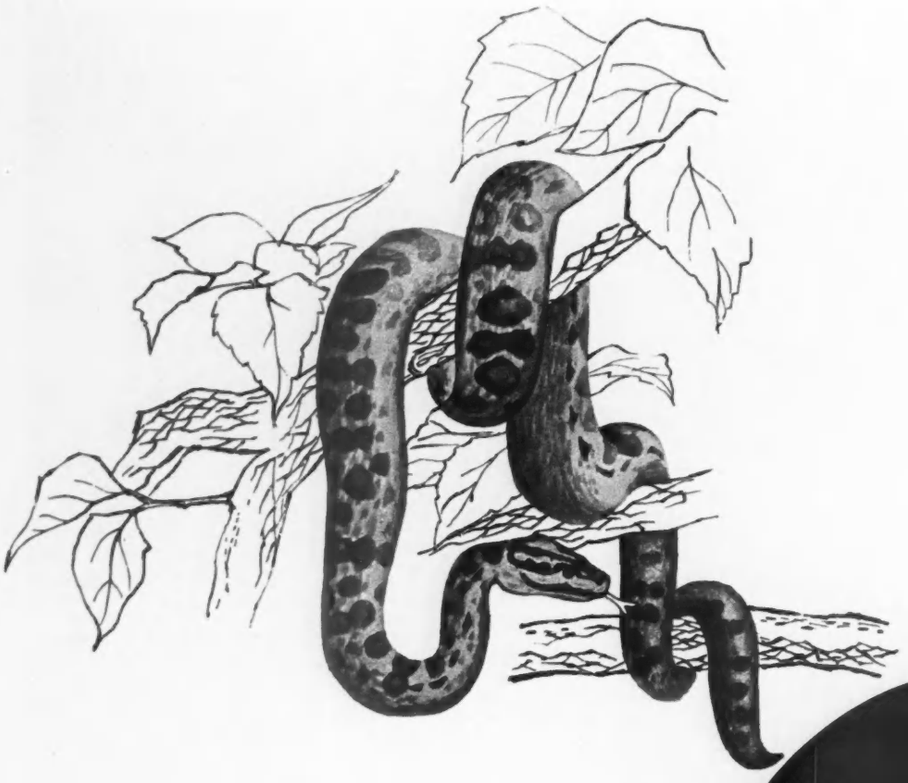

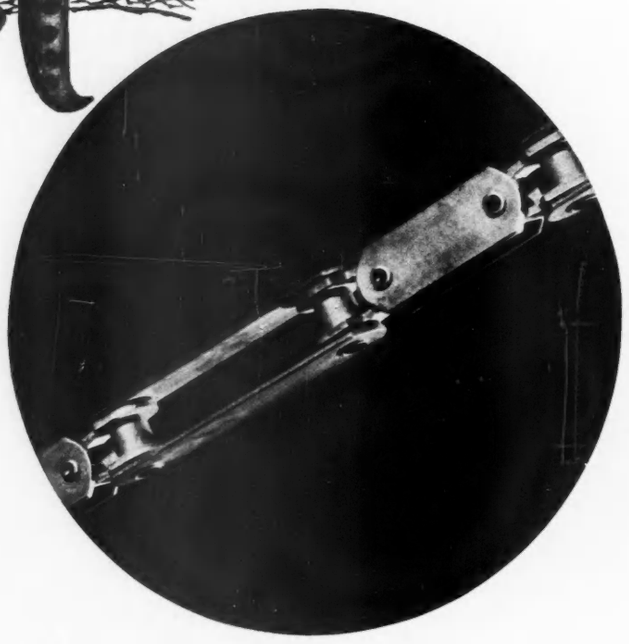

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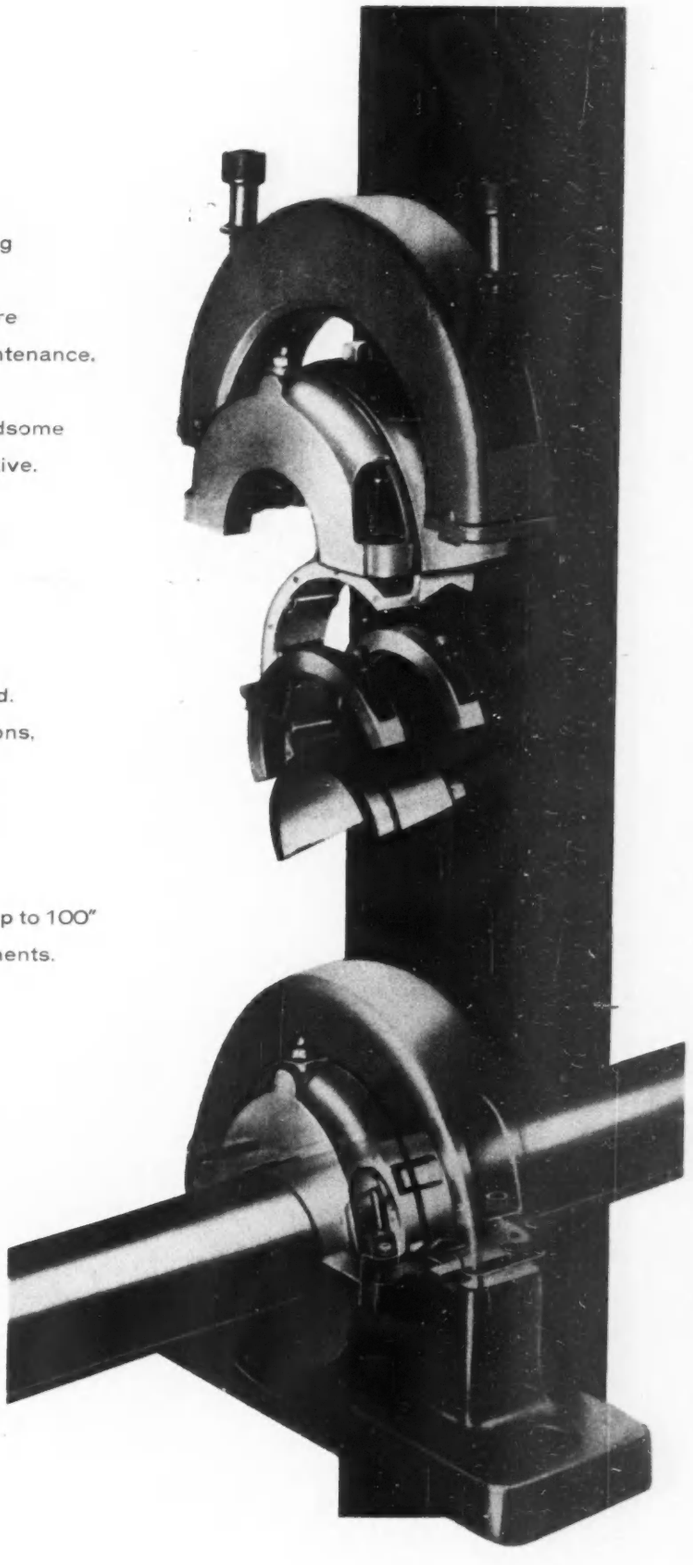

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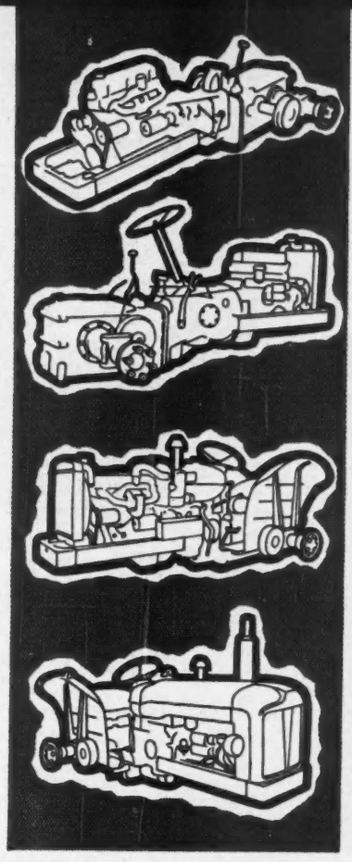

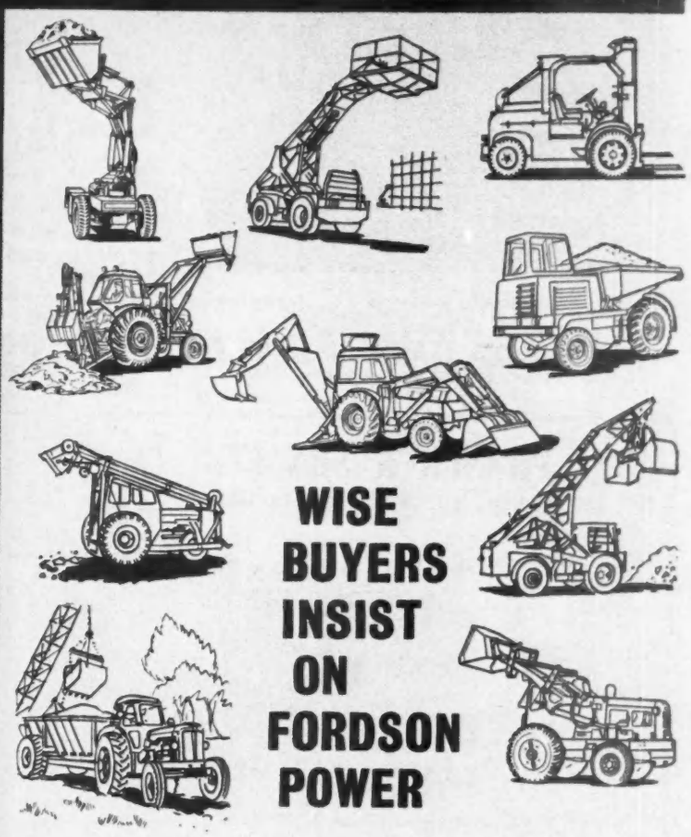

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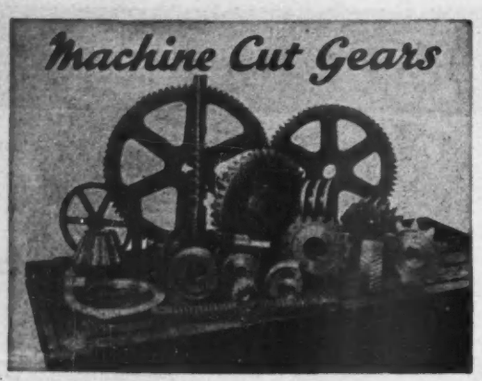

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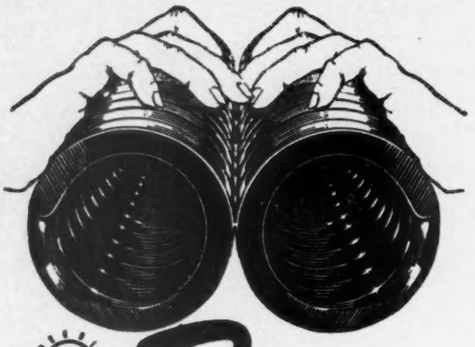

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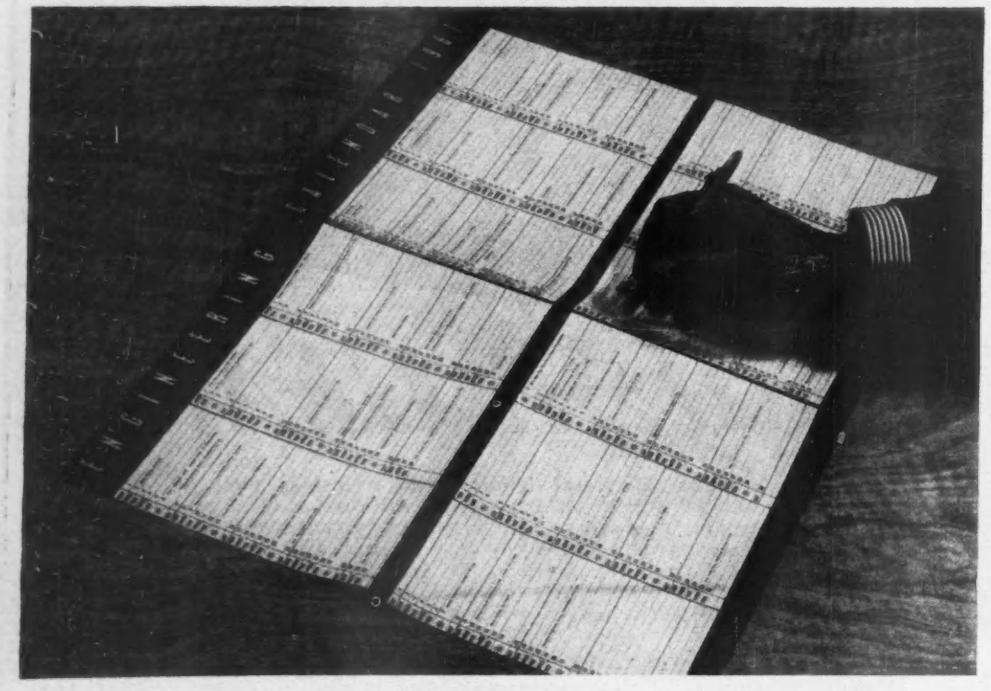

With a whole year on one page, this is an ideal *planning* calendar ; it also reminds you of the *main events* of 1961 of interest to engineering firms and their overseas connections. Additional events of special interest to you can be recorded from the weekly 'Events in Advance' feature published in 'Engineering'. Copies of this calendar are available *gratis* from

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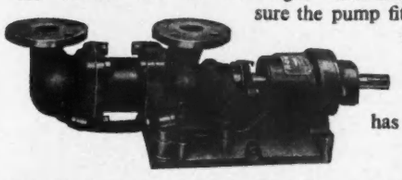

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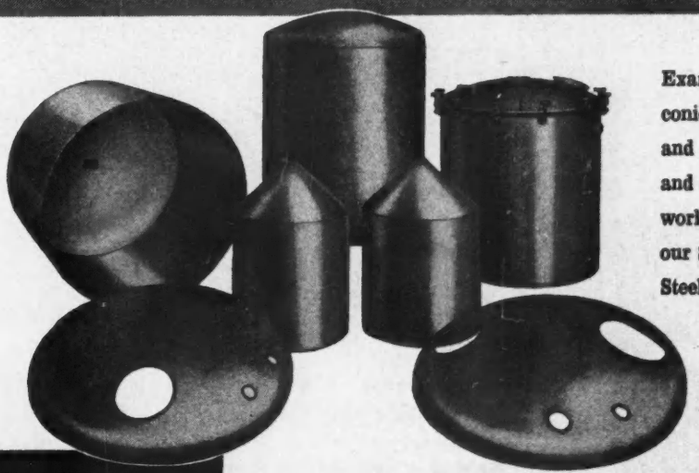

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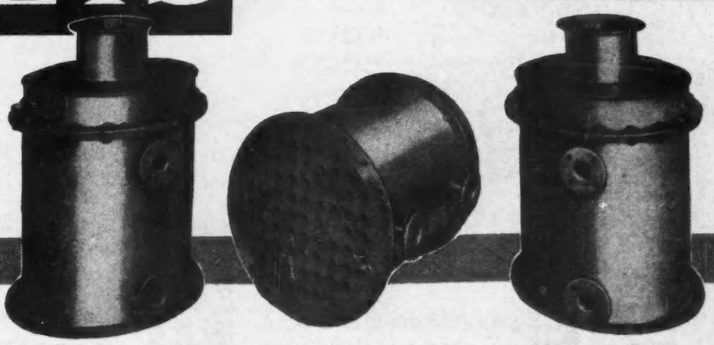

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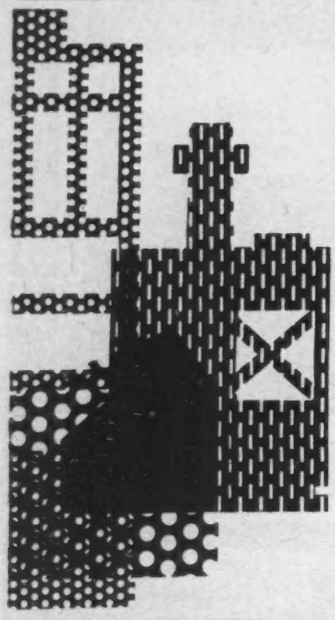

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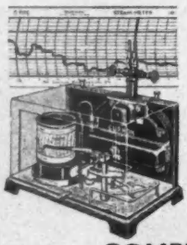

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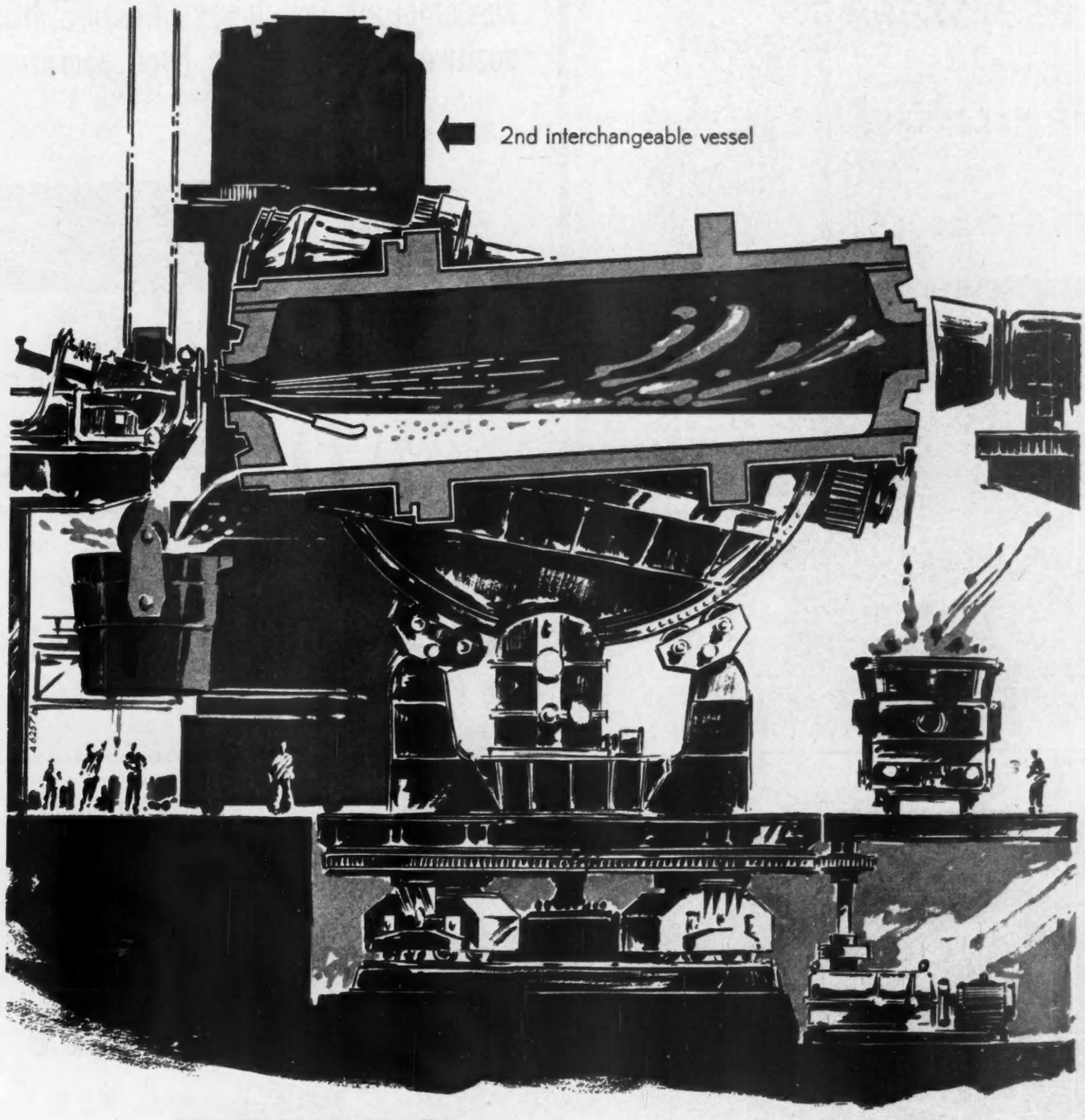

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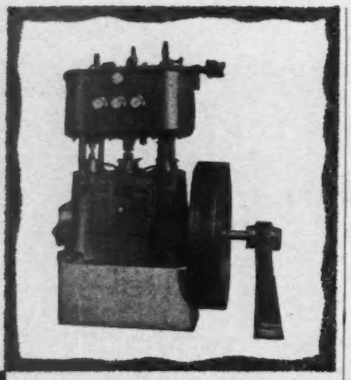

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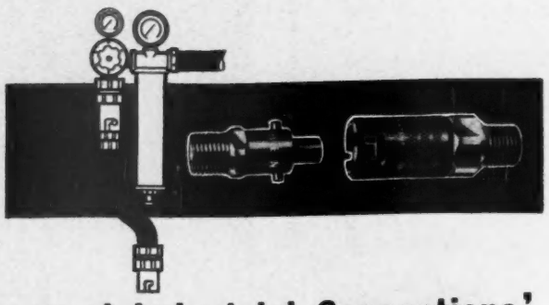

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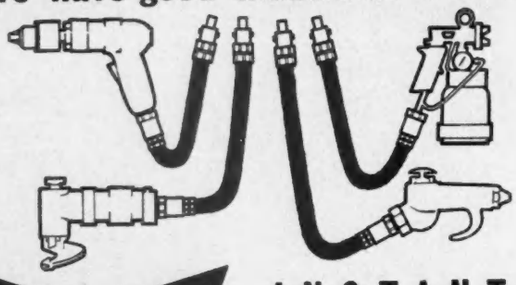

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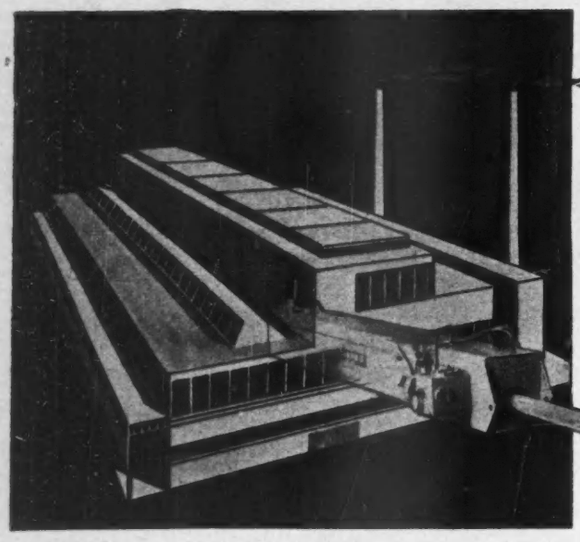

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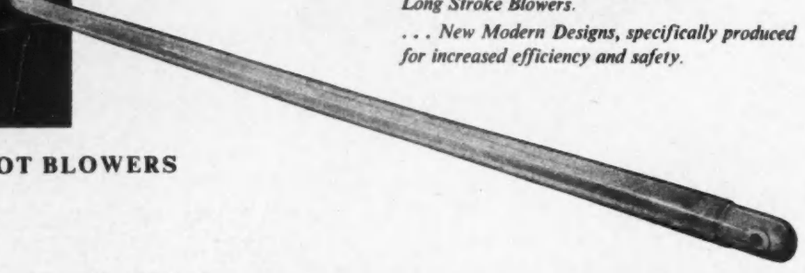

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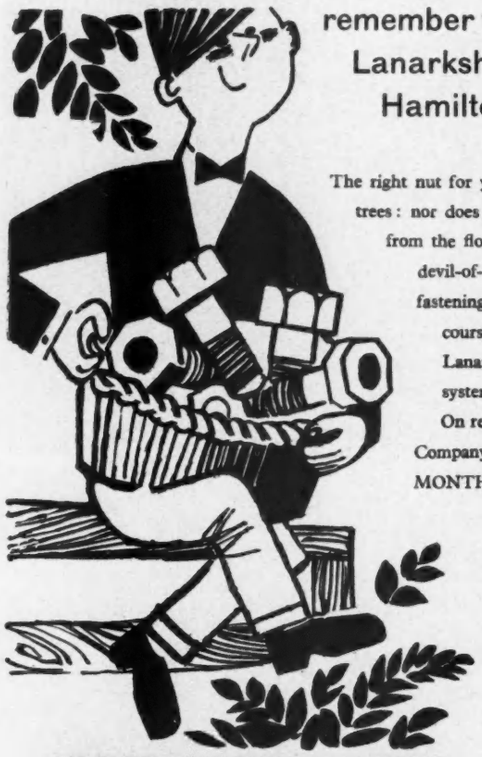

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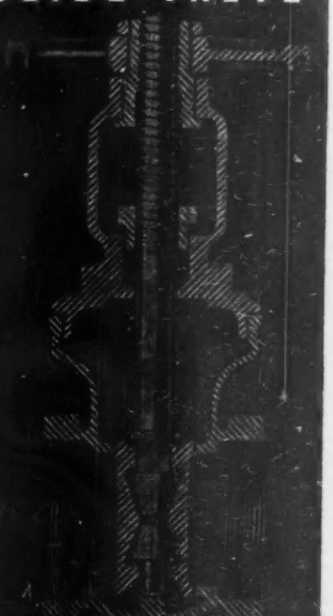

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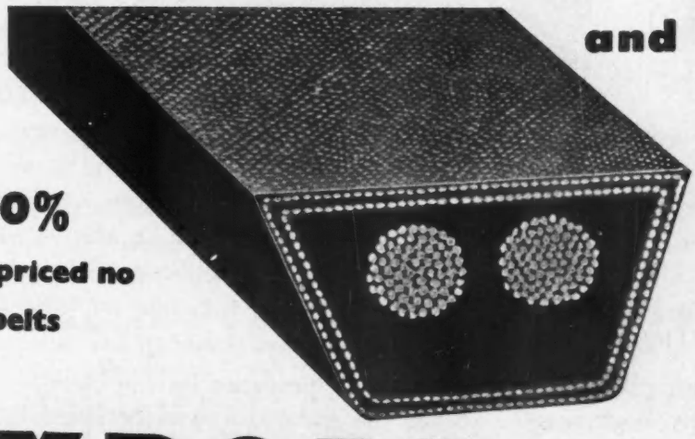

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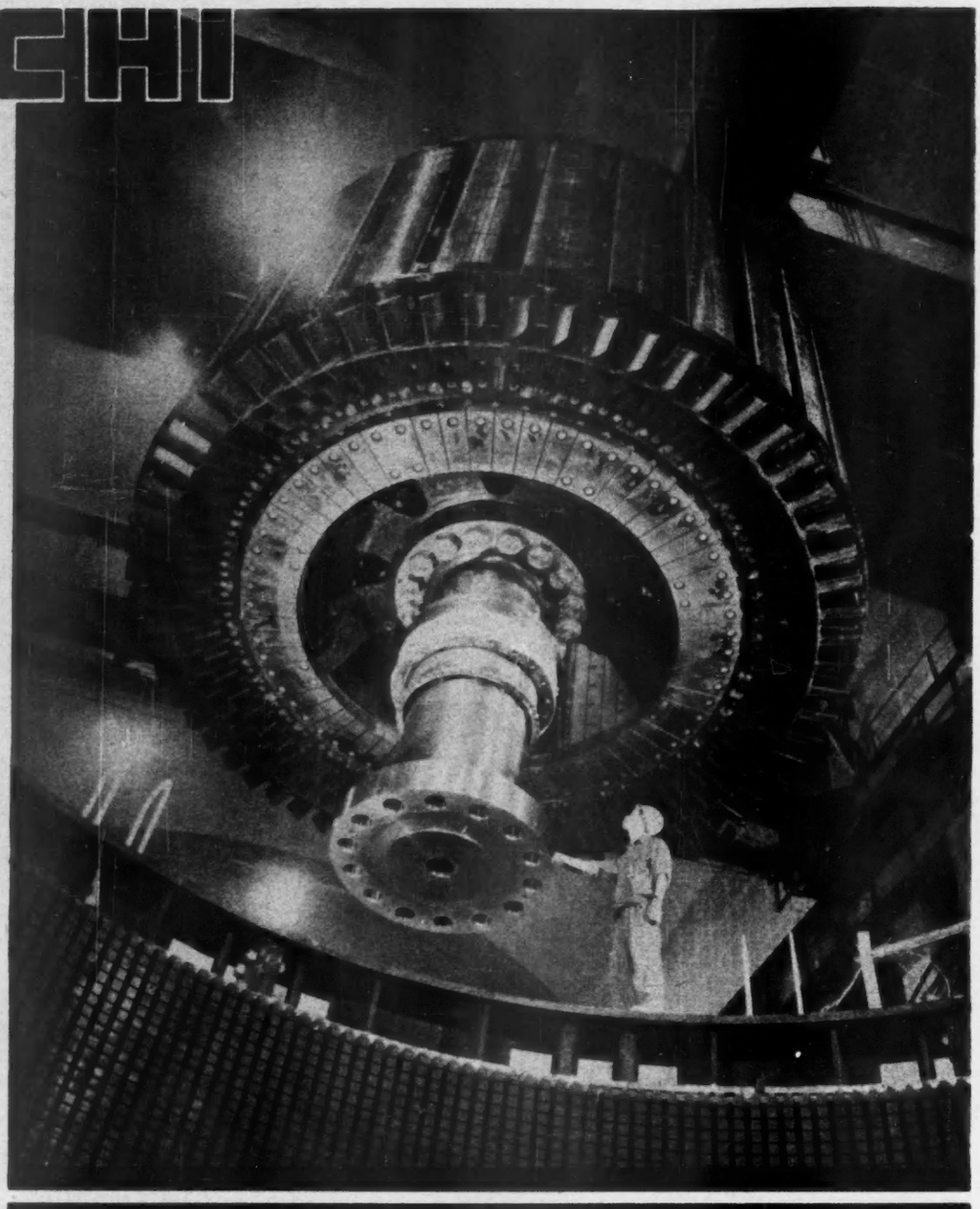

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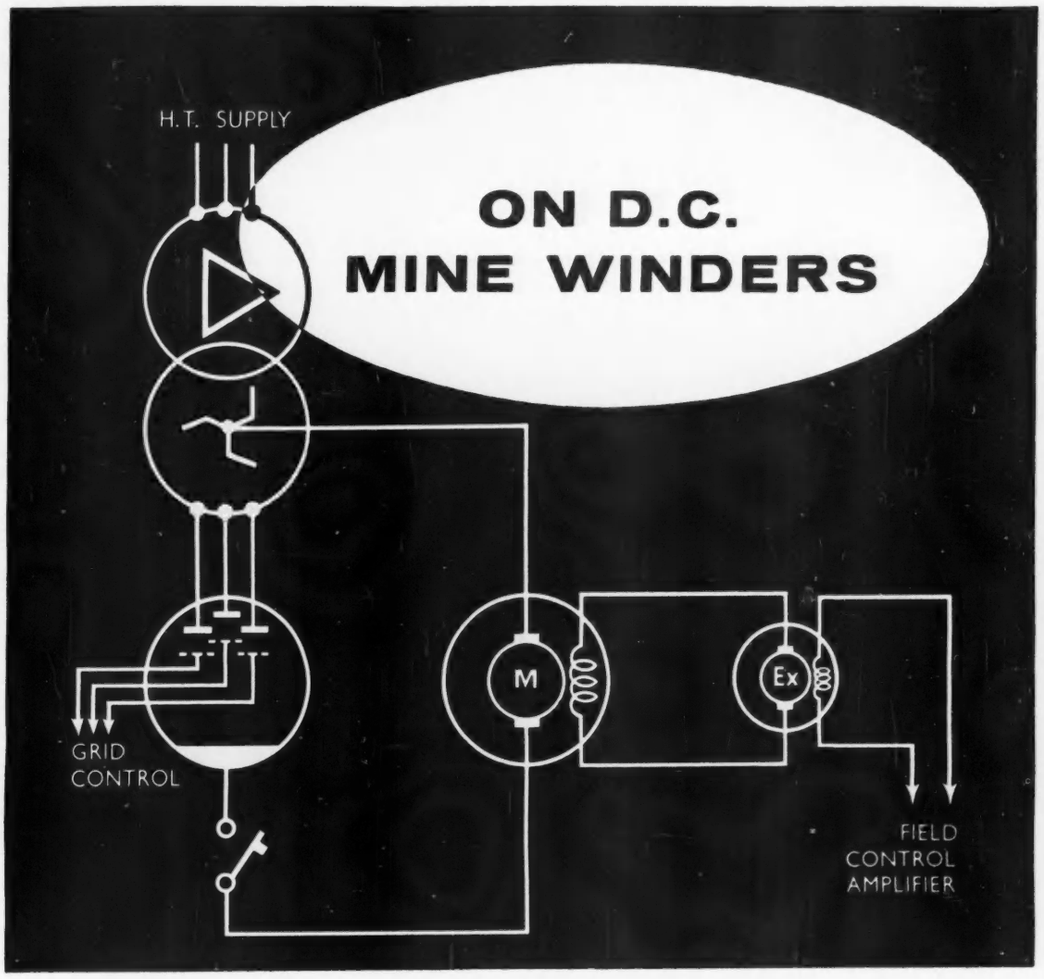

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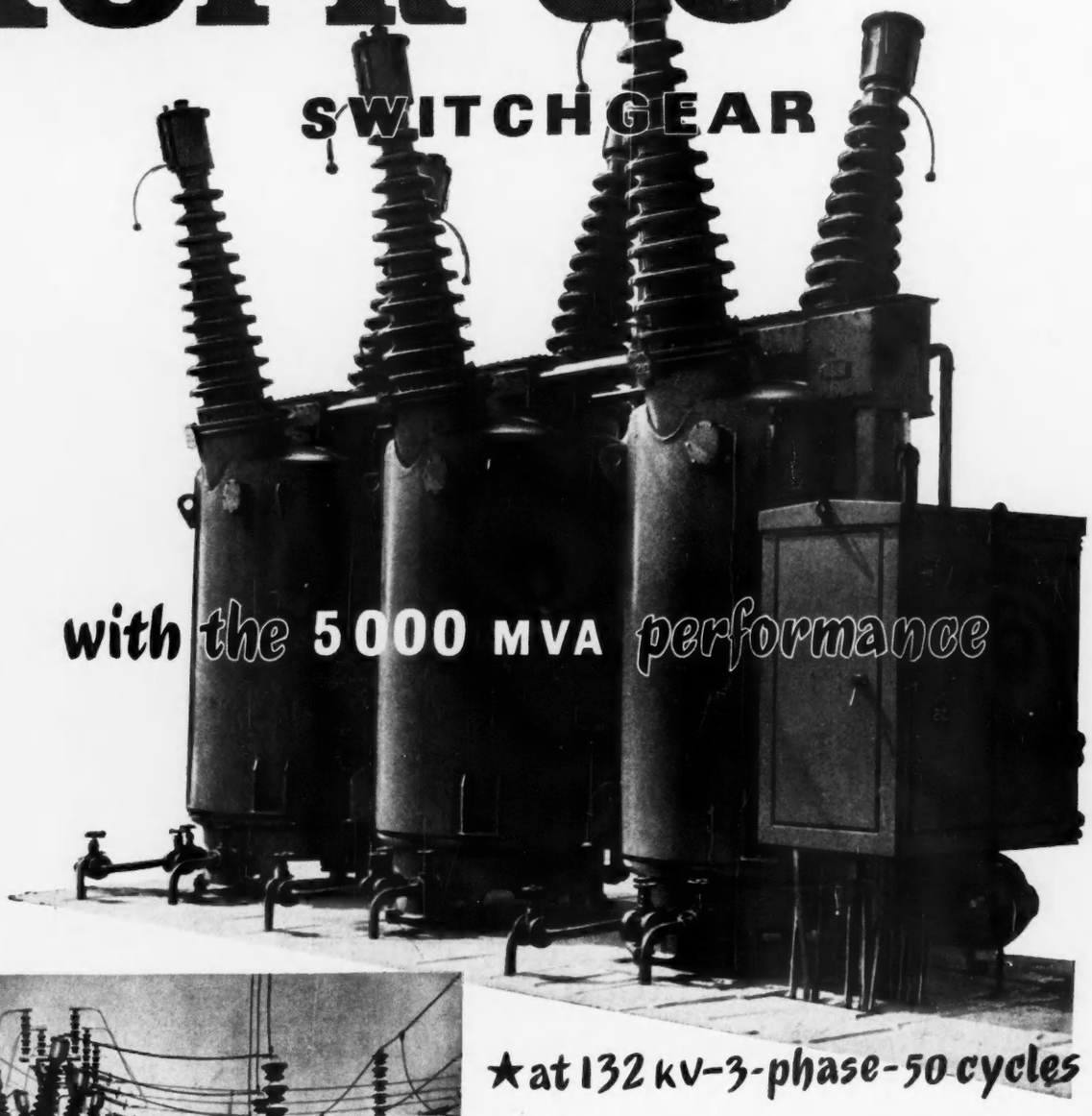

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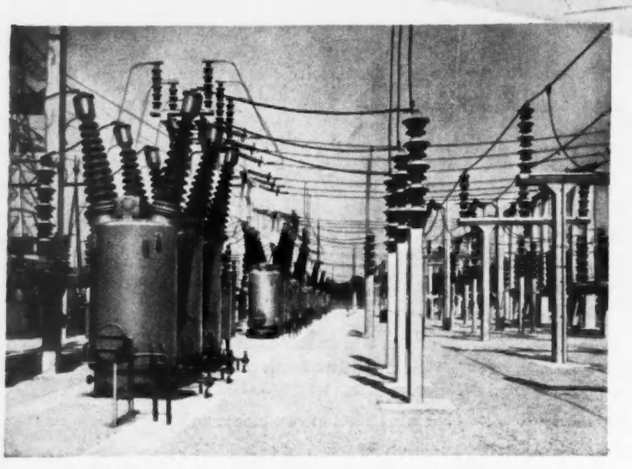

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The challenge presented by the need for bulk-oil circuit-breakers capable of dealing with the higher fault levels now experienced through the 'Supergrid' has been adequately met by the introduction, at many points in the supply system, of the Type XOPR 60 circuit-breaker.

With its outstanding performance it is, without question, unique in circuit-breaker design, and suitable for service in varied climatic conditions.

Manufactured at the Higher Openshaw Works of

AEI Associated Electrical Industries Ltd.

Switchgear Division

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